Distribution, Timing, Change in Size, and Stomach Contents of Juvenile Chinook and Coho Salmon Caught in Cowichan Estuary and Bay, 1973, 1975, 1976

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DISTRIBUTION, TIMING, CHANGE IN SIZE, AND STOMACH CONTENTS OF JUVENILE CHINOOK AND COHO SALMON CAUGHT IN COWICHAN ESTUARY AND BAY, 1973, 1975, 1976[1]

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ABSTRACT

Argue, A.W., Bruce Hillaby, and C.D. Shepard. 1985. Distribution, timing, change in size, and stomach contents of juvenile chinook and coho salmon caught in Cowichan estuary and bay, 1973, 1975, 1976. Can. Tech. Rep. Fish. Aquat. Sci. 1431: xiv + 149 p.

In 1973, 1975 and 1976, field studies were conducted to determine the distribution, abundance, duration of residence, growth and feeding habits of juvenile chinook (Oncorhynchus tshawytscha) and coho (O. kisutch) salmon on the Cowichan estuary and in Cowichan Bay. Chinook and coho were captured with pole seine, tow net, beach seine and purse seine in 1973, with beach seine and purse seine in 1975, and with purse seine in 1976. Surveys took place from the last two weeks in March to the last two weeks in October; different time periods were covered each year. In 1975 and 1976, a number of stations outside Cowichan Bay were fished by purse seine. Surveys in 1975 and 1976 coincided with releases of large numbers of coded-wire tagged and adipose clipped chinook juveniles (June-July) and coho smolts (April-June) from several sites on the Cowichan and Koksilah Rivers (coho) and on the estuary (chinook).

Juvenile chinook and coho fry were captured on the estuary between early April and late June. Chinook then moved into deeper water at the head of Cowichan Bay, just adjacent to the estuary, and to intertidal beaches around the perimeter of the bay. Coho smolts did not appear to be abundant in the catches of the different nets on the estuary, or in beach seine catches at intertidal stations around the perimeter of the bay, but were abundant at deeper water stations fished by purse seine at the head of the bay and around the edges of the bay. Neither species was abundant at stations in water exceeding 45 m in the middle of Cowichan Bay. Large numbers of both species were captured at nearshore stations outside Cowichan Bay.

In 1976, Many chinook and coho stayed resident in Cowichan Bay until October. The percentage of marks in the catch inside Cowichan Bay did not change appreciably during this time; few non-Cowichan marks were recovered. Thus it was concluded that there was little immigration of other stocks into the bay. There was evidence that later migrants from freshwater tended to disperse less from Cowichan Bay than early migrants. There was also evidence that as chinook and coho grew they moved from the estuary to nearshore waters of Cowichan Bay and then to nearshore waters outside the bay.

Both chinook and coho in 1976 grew at a rate of

approximately one millimeter (fork length) per day between July and September. Growth rate appeared to slow in late September.

Juvenile Pacific herring (Clupea harengus pallasi) were present in large numbers in the purse seine catch, and were by far the dominant diet item (by weight) of chinook and coho caught between July and October at stations in Cowichan Bay. Decapod larvae, mostly zoea of porcellanid crabs, were numerically the most common diet item. Estuarine benthic organisms were the dominant diet items of chinook and coho caught on the estuary flat in March, April and May.

Key Words: juvenile salmon, Cowichan Estuary, coded-wire tagging, movement, growth, stomach contents.

RESUMÉ

Argue, A.W., Bruce Hillaby, and C.D. Shepard. 1985. Distribution, timing, change in size, and stomach contents of juvenile chinook and coho salmon caught in Cowichan estuary and bay, 1973, 1975, 1976. Can. Tech. Rep. Fish. Aquat. Sci 1431: xiv + 149 p.

En 1973, 1975 et 1976, on a effectué des études sur le terrain pour déterminer la distribution, l'abondance, la durée de séjour, la croissance et les habitudes alimentaires de jeunes saumons quinnats (Oncorynchus tshawytscha) et cohos (O. kisutch) dans l'estuaire et la baie Cowichan. Pour capturer les saumons quinnats et cohos, on s'est servi en 1973 de sennes à perche, de filets trînants, de sennes de rivage et de sennes coulissantes, en 1975 de sennes de rivage et de sennes coulissantes et, finalement, en 1976 de sennes coulissantes. Les études ont été réalisées contre les deux derniéres semaines de mars et les deux derniéres semaines d'octobre, mais à une période différente à chaque année. En 1975 et 1976, on a pêché à la senne coulissante à un certain nombre de stations situées au-delà de la baie Cowichan. En 1975 et 1976, les études ont coincidé avec la remise à l'eau de grandes quantités de jeunes saumons quinnats (juin et juillet) et cohos (avril à juin) marqués à l'aide d'une étiquette métallique codée et par rognage de la nageoire adipeuse qui provenaient de plusieurs endroits situés dans les riviéres Cowichan et Koksilah (saumon coho) et dans l'estuaire (saumon quinnat).

De jeunes saumons quinnats et des alevins de saumon coho ont été capturés dans l'estuaire entre le début d'avril et la fin de juin. Les saumons quinnats se sont rendus ensuite dans des eaux plus profondes à la téte de la baie Cowichan dans une zone immédiatement adjacente à l'estuaire et sur les plages intertidales autour de la baie. Les jeunes saumons cohos ne semblaient pas étre nombreux dans les prises obtenues à l'aide des différents filets utilisés dans l'estuaire ou dans les prises recueillies par les sennes de rivage à des stations intertidales situées autour de la baie, mais ils étaient abondants à des stations situées en eaux plus profondes où on utilisait des sennes coulissantes au fond et en bordure de la baie. Aucune des deux espéces ne se rencontrait en abondance aux stations où la prodondeur dépassait 45 m dans le milieu de baie Cowichan. On a capturé ces deux espéces en grands nombres à des stations littorales situées à l'extérieur de la baie Cowichan.

En 1976, un grand nombre de saumons quinnats et cohos sont demeurés dans la baie Cowichan jusqu'en octobre. Au cours de cette période, le pourcentage d'individus marqués dans les prises n'a pas

changé de façon appréciable; on a recapturé peu d'individus marqués ne provenant pas de la baie Cowichan. Par conséquent, on a conclu qu'il y a eu peu d'immigration d'autres stocks dans la baie. On a remarqué que les migrateurs tardifs venant des eaux douces avaient tendance à se disperser moins à partir de la baie Cowichan que les migrateurs précoces et que, au fur et à mesue que les saumons quinnats et cohos se développaient, ils se rendaient de l'estuaire aux eaux côtiéres de la baie Cowichan puis à celles se trouvant au-delà de la baie.

En 1976, entre juillet et septembre, le rythme de croissance des saumons quinnats et cohos a été d'environ un millimétre (longueur à la fourche) par jour. Il a semblé se produire un ralentissement de la croissance à la fin septembre.

On a retrouvé dans les prises obtenues au moyen de sennes coulissantes de grandes quantités de jeunes harengs du Pacifique (Clupea harengus pallasi) qui constituaient, et de loin, l'élément dominant (par poids) du régime alimentaire des saumons quinnats et cohos capturés entre juillet et octobre à des stations situées dans la baie Cowichan. Les larves de décapopes, surtout des zoés de crabes de la famille des porcellanidés, étaient numériquement l'élément le plus commun du régime alimentaire. Les organismes benthiques de l'estuaire étaient les éléments dominants du régime alimentaire des saumons quinnats et cohos capturés sur les haut-fonds de l'estuaire en mars, avril et mai.

Mots-clés: jeunes saumons, estuaire de Cowichan, pose d'une étiquette métallique codée, déplacement, croissance, contenus stomacaux.

DISTRIBUTION, TIMING, CHANGE IN SIZE, AND STOMACH CONTENTS OF JUVENILE CHINOOK AND COHO SALMON CAUGHT IN COWICHAN ESTUARY AND BAY, 1973, 1975, 1976

1.0 INTRODUCTION

The Cowichan estuary, one of the largest estuaries in British Columbia, is supplied with freshwater from the Cowichan and Koksilah Rivers (Figures 1 and 2). Annual chinook (Oncorhynchus tshawytscha) and coho (O. kisutch) escapements to these rivers are substantial, ranging from 2,000 to 15,000 chinook and from 10,000 to 110,000 coho (Marshall et al. 1976); several million juveniles of these species migrate to the estuary each spring (Argue, Patterson and Armstrong 1979; Armstrong and Argue 1977; Lister, Walker and Giles 1971; Sparrow 1968).

Concern in the 1970's over effects of industrial development on estuary habitat used by juvenile salmonids (Bell and Kallman 1976) led to research studies on several British Columbia estuaries, including the Cowichan. At the same time juvenile chinook and coho from the Cowichan and Koksilah Rivers were coded-wire tagged to estimate ocean distribution and catch by commercial and recreational fisheries (Argue, Patterson and Armstrong 1979; Armstrong and Argue 1977).

This report presents analyses of distribution, abundance, duration of residence, growth and feeding for marked and unmarked juvenile chinook and coho found on the Cowichan estuary and in Cowichan Bay. Results are also presented for chinook and coho juveniles caught at stations outside Cowichan Bay. Past estimates of juvenile population size are reviewed. These results add to the growing literature (eg. Healey 1980, 1982; Levy and Northcote 1982; Reimers 1973) on the importance of estuaries to growth and survival of migrant juvenile salmon.

1.1 Study Design

Field studies were conducted between 1973 and 1976 on the Cowichan estuary, on intertidal beaches and in deeper water in Cowichan Bay, and in deeper water outside Cowichan Bay. Juveniles were captured on the intertidal mudflat of the estuary, called the estuary flat (Figure 1), with beach seine, tow net and pole seine from March to August in 1973, and were captured with beach seine on intertidal beaches around the edge of

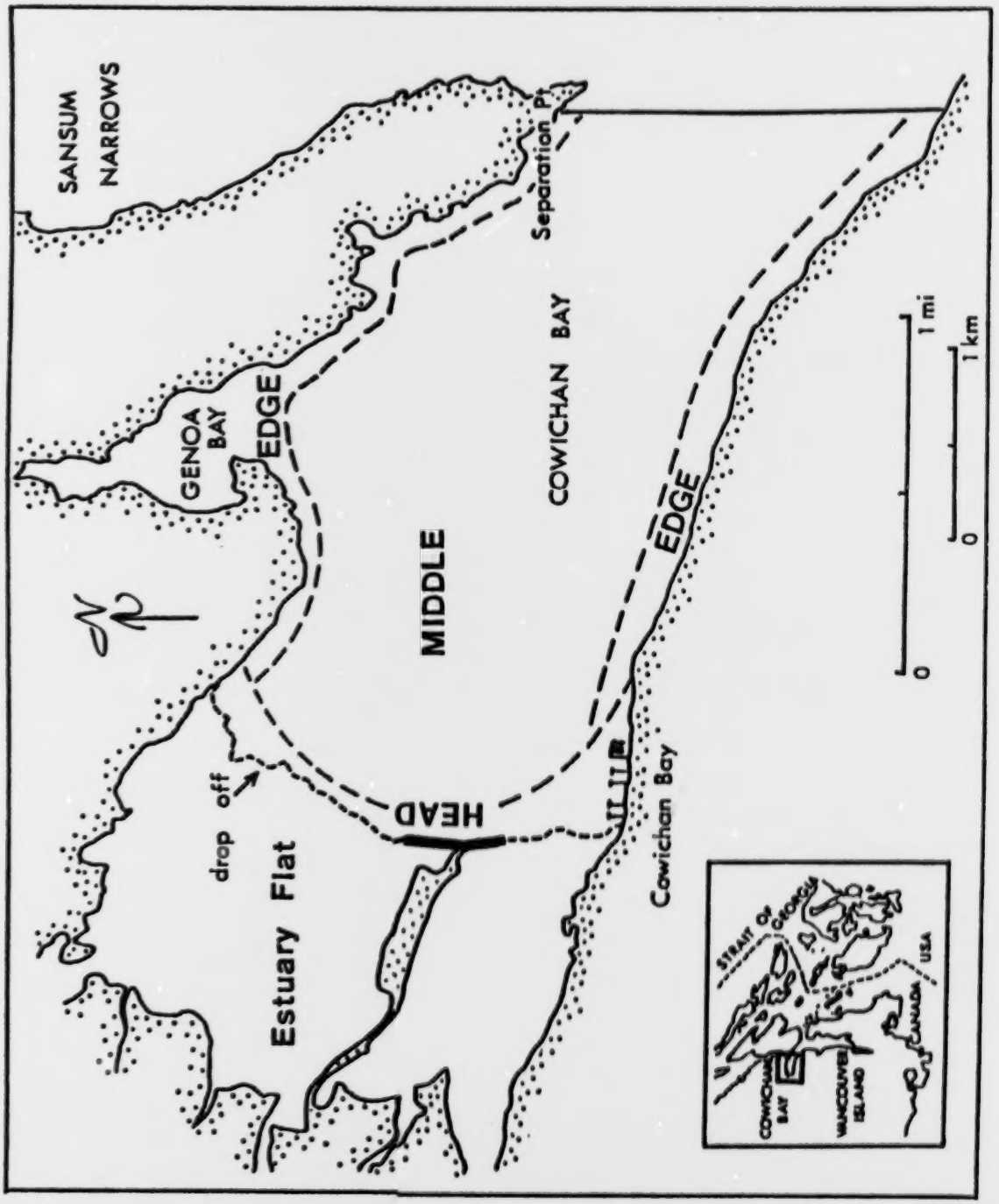

Fig. 1. Boundaries of areas used for grouped sampling stations inside Cowichan Bay. Cowichan Bay boundary indicated by solid line.

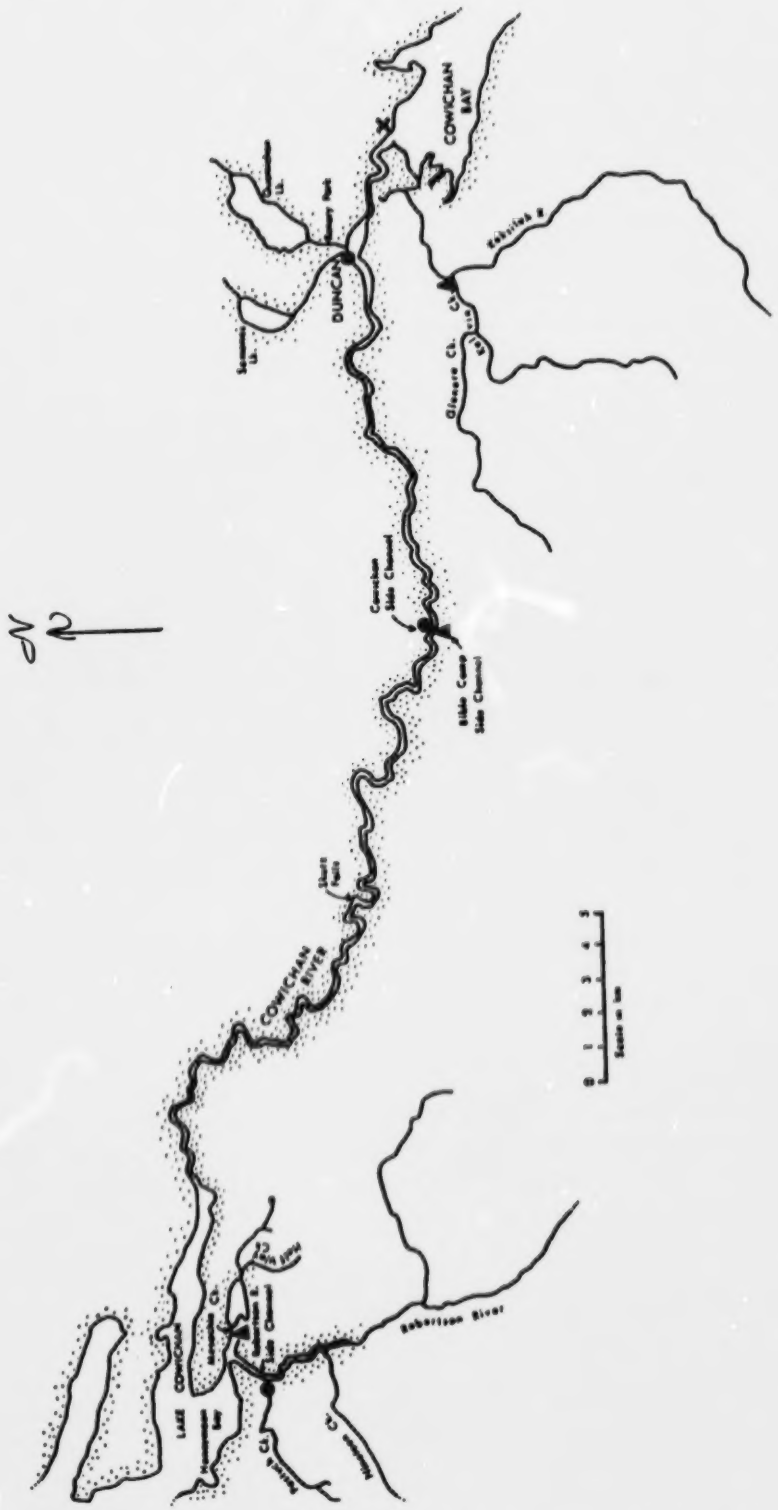

Fig. 2. Location map of the Cowichan and Koksilah River systems showing juvenile chinook and coho tagging sites. Circles denote coho smolt tagging sites used in 1975 - 1976; triangles denote coho tagging sites used only in 1975; and the cross is the chinook tagging site used in 1975 - 1976. Source: Lister, Patterson and Wallace (1981).

Cowichan Bay from late April to late July in 1975. Along the delta front or dropoff at the seaward edge of the estuary flat, juveniles were captured by tow net in 1973. In deeper, nearshore waters of Cowichan Bay, juveniles were captured by purse seine from early March to early September in 1973, from early April to the end of July in 1975, and from late May to late October in 1976. Purse seining also took place at various locations outside Cowichan Bay (Figure 3) during June and July in 1975 and from June to September in 1976. Table 1 shows the timing of sampling by each gear type.

For the purpose of this study the sampling stations for purse seine and beach seine have been grouped into four general areas: 1) estuary flat and nearshore waters at the head of Cowichan Bay, designated "head of bay", 2) intertidal beaches and nearshore waters along the edges of Cowichan Bay, designated "edge of bay", 3) deeper water designated "middle of bay" and 4) nearshore waters "outside Cowichan Bay". All tow net and pole seine sampling took place at the head of the bay. Figure 1 shows boundaries for station groupings.

Inside Cowichan Bay, all net gears were fished in a standard manner at each station, without regard for the presence of juvenile salmon, so that catch per set could be assumed to measure relative abundance. Outside Cowichan Bay, the purse seine was seldom set unless juveniles were considered present.

Chinook and coho juveniles were marked with coded-wire tags (Jefferts, Bergman and Fiscus 1963) and adipose clips at several locations in freshwater (coho) and in the estuary (chinook) (Figure 2) between April and July in 1975 and 1976.

Biological samples for size, age and stomach content analysis were collected from unmarked (1973 and 1975) and marked (1975 and 1976) juveniles. Adult returns of marked and unmarked chinook and coho were enumerated between 1976 and 1979 (Lister, Thorson and Wallace 1981). Estimates of commercial and recreational catches of coded-wire tagged chinook and coho were obtained from preliminary analyses (Margaret Birch, pers. comm.) of data collected by Mark Recovery Programs in Canada (Anon 1985, Argue 1976) and the United States.

1.2 Study Area

The Cowichan River drains 84,000 hectares of watershed and the Koksilah River drains 20,900 hectares (Lister, Thorson and Wallace 1981). These rivers, located on the east coast of southern Vancouver Island, enter the ocean through Cowichan Bay at 48° 45'N, 123° 43'W. Maximum flows occur during winter months. The average mean monthly flow (1913-1973), measured at

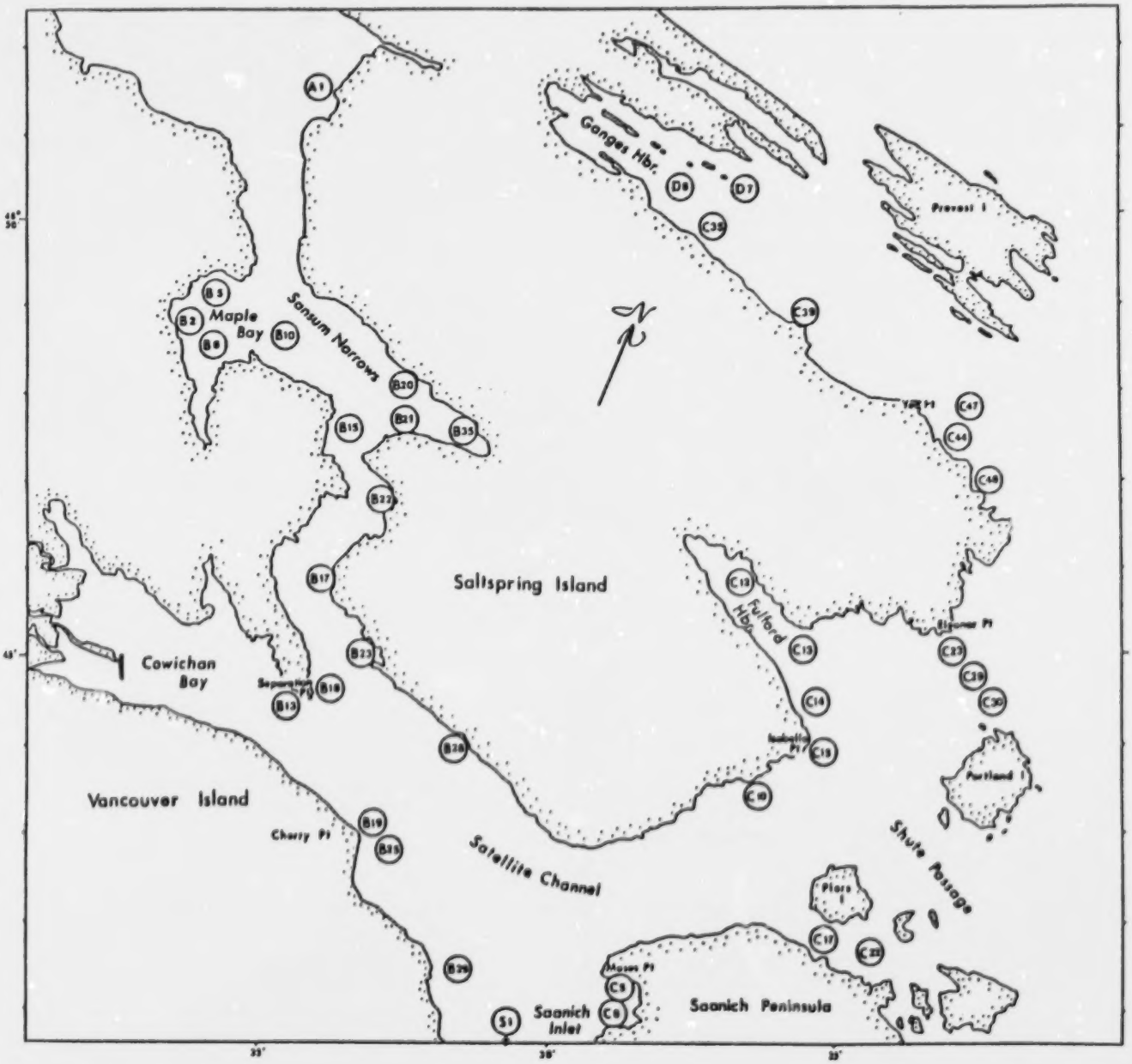

Fig. 3. The marine study area and locations of purse seine sampling stations outside of Cowichan Bay (circled alphanumeric codes).

the outlet to Cowichan Lake, was 45 m^3/sec, the maximum mean monthly flow was 181m^3/sec in December 1964 (Bell and Kallman 1976).

Little oceanographic data have been collected in Cowichan Bay or on the estuary. Water sampling on 16 September 1975 (Anon 1980) showed salinities ranging from 6°/oo to 20°/oo over most of the estuary flat, and surface salinities ranging from 24°/oo to 26°/oo along the estuary dropoff. At the M.V Laymore station, approximately one-half kilometer seaward from the dropoff, the salinity and temperature profiles suggested a pycnocline at approximately two meters depth; there was an oxygen minimum at four meters depth.

2.0 METHODS

2.1 Purse Seine

The FV Roanna (OAL 32 ft, 9.8 m) was used in 1973 (8 March to 5 September), 1975 (29 April to 24 July) and 1976 (27 May to 28 October) to carry out purse seine sampling. The purse seine was 100 fathoms in length by 8 fathoms in depth (182.9 x 14.6 m), and consisted of 25 fm of one inch (25.4 mm) mesh, 50 fm of one-half inch (12.7 mm) mesh and a 25 fm bunt of one-quarter inch (6.4 mm) mesh.

Stations one to five in 1973, one to eight in 1975, and one to ten in 1976 (Figure 4) were usually fished at least once per biweekly period. Stations 3.5 and 4.5 at the head of the bay, and stations 2.5 and 6.5 (Skinner Point) around the perimeter of the bay were added in 1976; these stations were not sampled on a regular basis. Data for stations called "government wharf" and "Texaco Float" in the field records for 1976 were assigned to station three because of their close proximity to this station. Table 2 lists purse seine station numbers that were combined in the analyses into "head of bay", "edge of bay" and "middle of bay". Figure 3 shows the location of purse seine stations outside Cowichan Bay.

In Cowichan Bay, the purse seine was set during the day, regardless of the stage of the tide, when water depth on the sounder was 8 fm (14.6 m). Stations near the estuary drop-off and around the perimeter of the bay were over sloping bottoms so that the net, once set, could be in water that ranged in depth from <2 m to >15 m. The two mid bay stations were in deep water (>25 fm, 45 m). All purse seine sets in Cowichan Bay were made without regard for visual or other evidence of the presence of salmon.

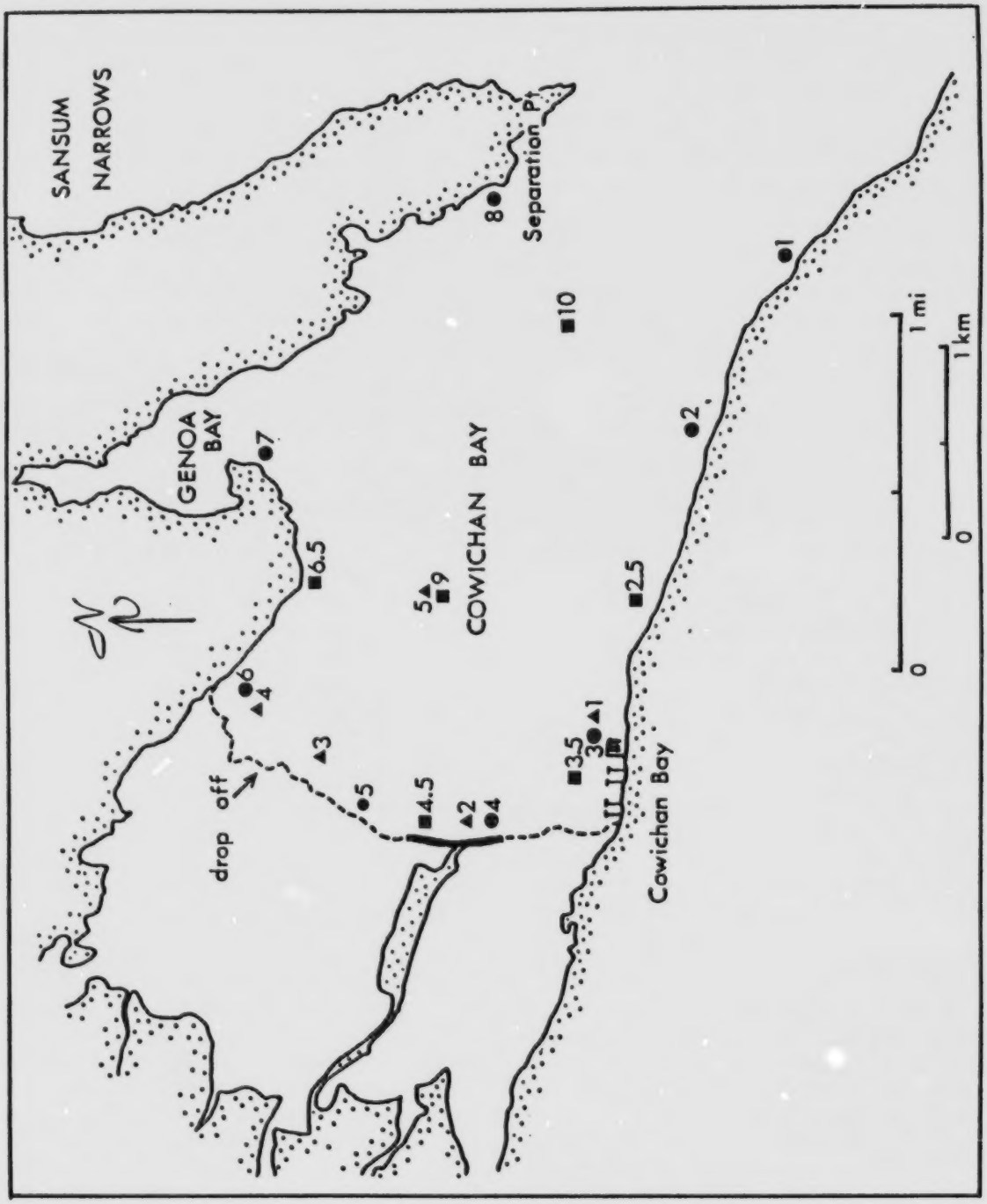

Fig. 4. Location of purse seine stations inside Cowichan Bay. Stations fished in 1973 are indicated by diamonds; stations fished in 1975 and 1976 are indicated by circles; stations fished only in 1976 are indicated by squares.

Outside Cowichan Bay, purse seine sets were generally made only when there was evidence of juvenile salmon at the water surface or on the echo sounder.

2.2 Beach Seine

The beach seine that was used in 1973 and 1975 was 1.33 fm (2.44 m) in depth by 15 fm (27.4 m) in length. The bunt of the net consisted of 5 fm (9.1 m) of one-quarter inch (6.4 mm) mesh netting, surrounded by wings of one-half inch (12.7 mm) netting. The beach seine was set from an outboard powered skiff except at stations 1.5, 2.5, 4.5 (ie. pole seine stations 1, 2, 4), and 7.5 where the net was set by hand.

Beach seining was carried out during periods of high tide regardless of time of day. In 1973, one set was made at each station (Figure 5) per two week sampling interval except at stations 1.5, 2.5, 4.5 and 7.5, which were only occasionally fished. In 1975, stations 6 and 16 on the estuary flat and stations 1, 8 to 14, and 17 to 19 around the edge of the bay were added. Stations 1, 2, 4, 5 and 7 were generally fished once or more every two weeks; stations 3 and 6 were not fished; and stations 8 to 19 were only occasionally fished between June 5 and July 24. Table 2 lists beach seine station numbers that were combined into "head of bay" and "edge of bay".

2.3 Pole Seine and Tow Net

The pole seine was 8 ft (2.4 m) long, 5 ft (1.5 m) high and the mesh size of the bunt was one-quarter in (6.4 mm). The dimensions of the tow net were length 23 ft (7 m), mouth 12 ft (3.5 m), and the mesh size of the throat was 1.25 in (3.18 cm) tapering to 1 in (2.5 cm) with a 0.5 in (1.27 cm) cod end.

Pole seining was used at low tide in 1973 to sample intertidal flood channels at seven stations across the estuary flat (Figure 6). Stations six and seven were not included on the figure because positions for these stations could not be determined. Station 3 was sampled at least once every two weeks between mid-April and the end of July; remaining pole seine stations were sampled on an irregular basis.

Tow netting was used at high tide in 1973 to sample two locations along the estuary dropoff (stations 2 and 4) and two intertidal flood channels (stations 1 and 2) on the estuary flat between the dropoff and points approximately two-thirds of the way towards the head of the estuary (Figure 6). Tow netting was conducted once every two weeks from the first week in April at

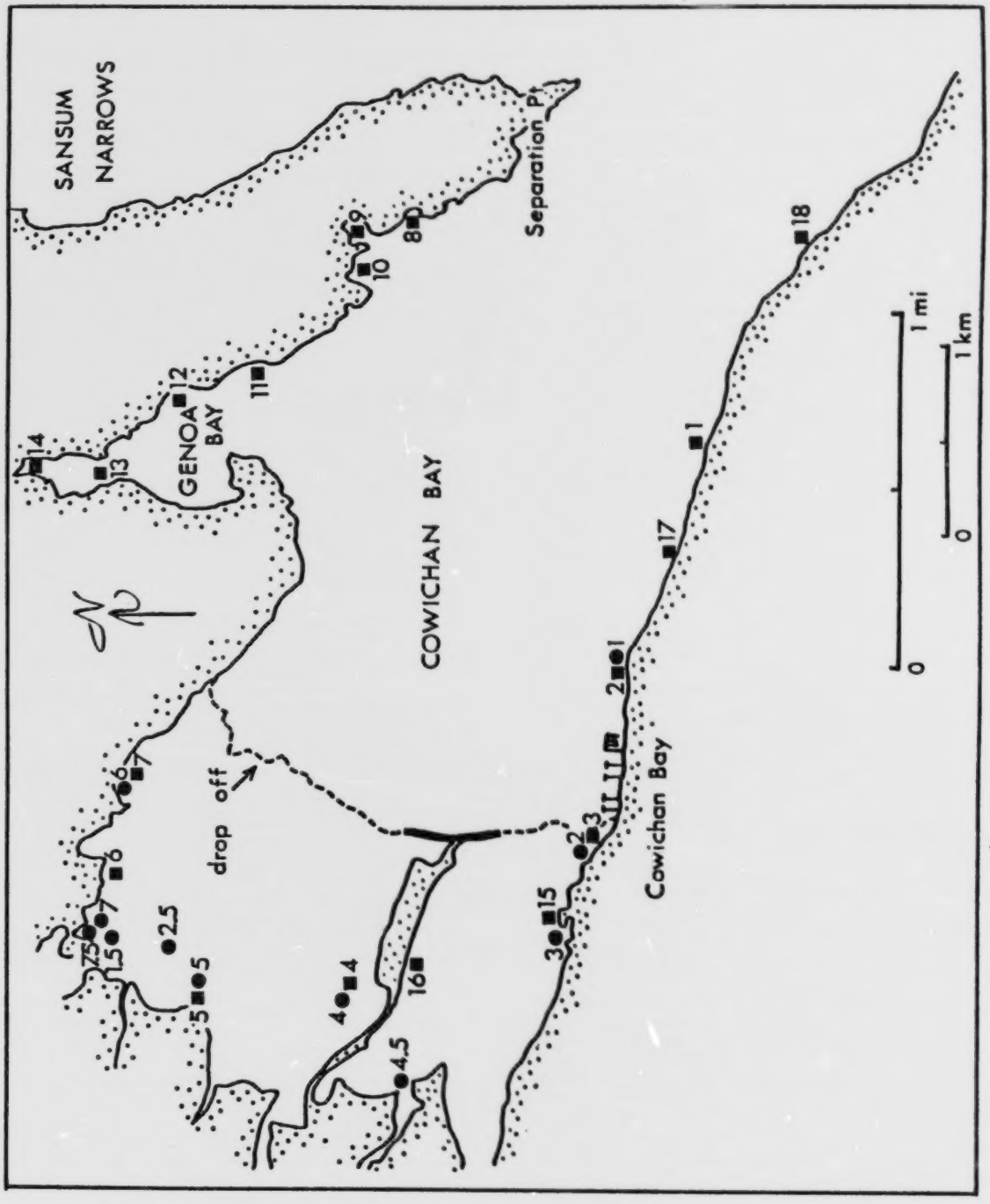

Fig. 5. Location of beach seine stations inside Cowichan Bay. Stations fished in 1973 are indicated by circles and stations fished in 1975 are indicated by squares. Station 19 in 1975 was near Cherry Point, which is outside the map boundary.

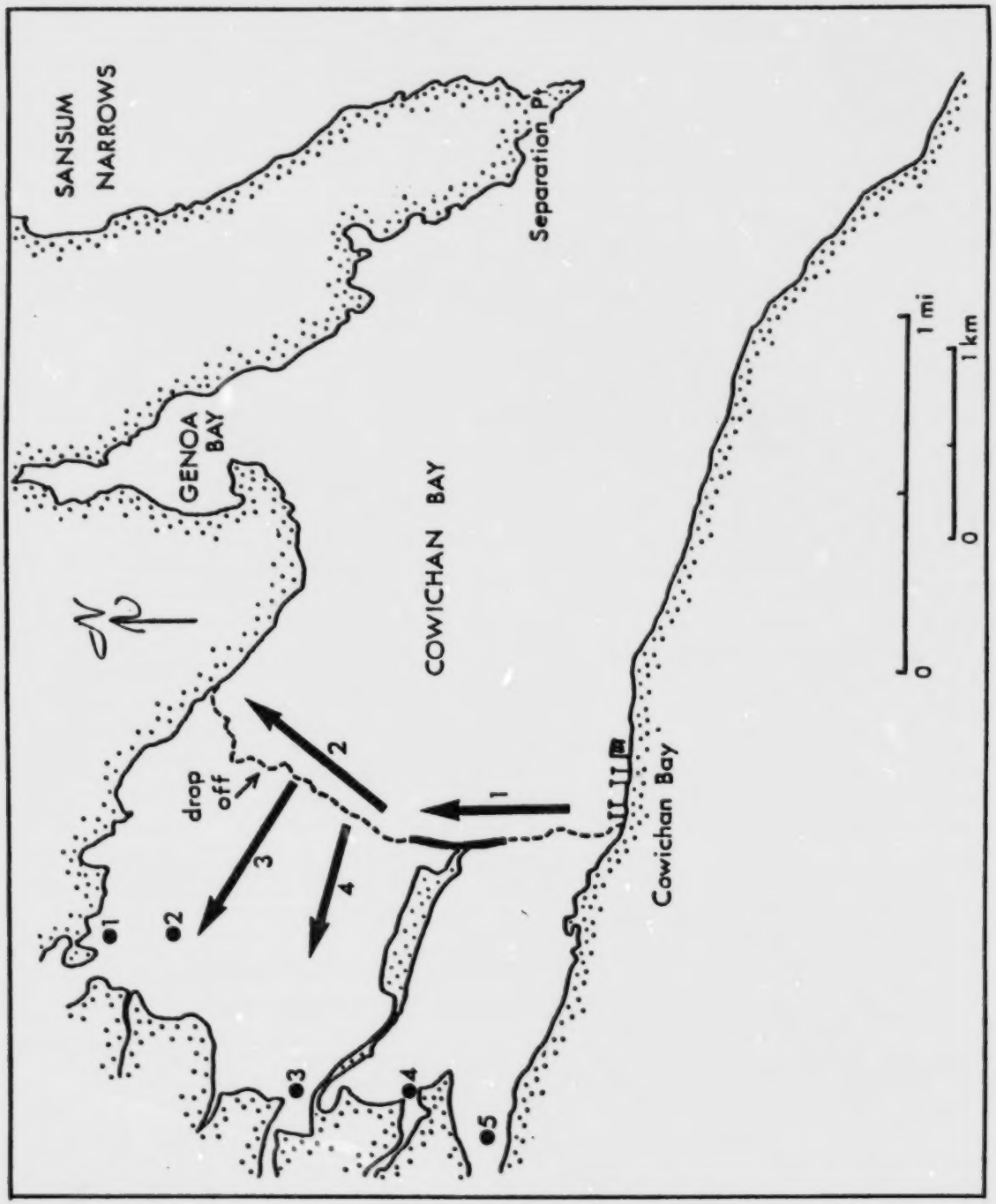

Fig. 6. Pole seine (circles) and tow net (arrows) stations that were fished in 1973.

stations 1 and 2, and from the first week in May at stations 3 and 4. Tow netting continued until the first week in August.

2.4 Coded-wire Tagging and Recovery

2.4.1 Juvenile tagging and recovery

Coded-wire tagging (CWT) of fingerling chinook in 1975 and 1976 (1974 and 1975 brood years) took place from mid June to the first week of July on the north side of Cowichan Bay, just seaward of the estuary dropoff near the point where the main channel of the Cowichan River enters Cowichan Bay (Figure 2). Coho smolts (1973 brood) were tagged from mid April to mid June at three sites on the Cowichan River in 1975 (Rotary Park, Cowichan Side Channel, Pastuch Creek), and at the same three sites in 1976 (1974 brood) as well as at Mesachie Creek, which drains into Cowichan Lake, and at Kelvin Creek on the Koksilah River (Figure 2). Armstrong and Argue (1977) and Argue, Patterson and Armstrong (1979) describe juvenile tagging and enumeration methods.

Coho released at each tagging site carried several tag codes; chinook carried only one code each year. Table 3 presents the numbers of juveniles that were tagged and released from each of the sites, the tag codes, and the average size of tagged fish at time of tagging. At three of the freshwater tagging sites (Rotary Park, Mesachie Creek, Kelvin Creek), coho smolts carried CWT codes denoting migration timing. In the second to last column of the table, "early" refers to fish that were tagged before the date when approximately 50 percent of downstream migrants had been enumerated (between 17 and 24 May), "late" refers to fish tagged after this date, and "total" refers to groups of smolts for which the same tag code was used throughout the tagging period. The "upper", "middle" and "lower" designations refer to distances from the estuary (lower means closest to the estuary).

The total catch of juvenile chinook and coho by beach seine and purse seine in 1975 and 1976 was examined for fish missing the adipose fin. Most of these fish were retained for later reading of binary codes on the CWTs and for biological measurements.

2.4.2 Adult recovery and enumeration

Estimated catches of coded-wire tagged adults by commercial and recreational fisheries were based on data from Canadian and U.S. Mark Recovery Programs. Catch estimates based

on these data are considered preliminary and are from a report prepared by Aquatic Resources Limited in 1984 for the Department of Fisheries and Oceans (Margaret Birch, pers. comm.). Data sources for estimated catches of Cowichan CWT codes, as described in the Aquatic Resources report, were: 1) for Canadian commercial fisheries- published reports and preliminary reports of the Canadian Mark Recovery Program (recoveries from "combined" catch areas were excluded), 2) for Canadian recreational fisheries- observed CWT recoveries from the above sources, inflated by "awareness factors" of 0.252 for coho and 0.158 for chinook (The awareness factor is the ratio of adipose clipped salmon turned in voluntarily to the total number of marks in the catch), 3) for U.S. fisheries- an unpublished Department of Fisheries and Oceans report on wild stock tagging programs, and from reports by the U.S. Regional Mark Processing Center. Based on a recent analysis (Palermo 1985 MS), the awareness factors used here are too low, hence catch estimates from the Aquatic Resources report may be overestimated.

Lister, Thorson and Wallace (1981) described the 1976-1979 mark recovery and enumeration program for adult chinook and coho that returned to the Cowichan and Koksilah Rivers to spawn. They provided estimates of the return of marked and unmarked spawners, of the survival of juveniles to adult return, and of post liberation CWT loss. Estimates of adult return were based on Peterson tag and recapture and visual counts from an enumeration tower. Estimates of marks in the adult return were calculated from the product of the incidence of marks in samples of adults that were holding near the estuary dropoff and the estimates of adult return.

2.5 Biological Sampling of Juvenile Salmon

In 1973 and 1975, a maximum of ten chinook and ten coho from each set were preserved in 10 percent formalin for later laboratory measurement of size (fork length and wet weight) and stomach content. In 1976, only marked chinook and coho were retained for biological sampling.

The size sampling data reported in this paper are from marked chinook and coho juveniles that were sampled in 1975 and 1976. Size sampling data from unmarked juveniles were either unsuitable (1973) or unavailable (1975) for analysis.

Scale samples were taken from 18 marked chinook and 79 marked coho in 1975; scale samples were not taken in 1973 or 1976.

Stomach samples from 630 chinook and 505 coho in 1973,

and from 302 marked chinook and 197 marked coho in 1976 were analyzed for stomach content. Stomach content data from 21 marked chinook and 81 marked coho in 1975 have been lost.

The wet weight of the stomach and contents was recorded and then the contents were identified to the lowest possible taxonomic level. Each prey species or taxon was assigned a unique alphanumeric code. The diet item represented by some of the 1976 codes could not be located; these codes are identified by question marks in the tables. For each taxonomic category, the number of organisms within one millimeter length intervals was recorded.

2.6 Data Analysis

Catch and effort data were obtained from the field record sheets. However, in 1973 there were changes to the field identifications of salmon species, based on corroborating identifications completed in the laboratory. The lab data, available in summary form (Dave Barrett, pers. comm.), were used to correct records of coho fry and chinook juveniles obtained from field sheets.

The designation "coho" on field records for beach seine, pole seine and tow net sets was assumed to refer to age 0. coho fry; on purse seine records, "coho" was assumed to refer to age 1. coho "smolts".[1] All chinook juveniles were assumed to be age 0. based on ageing results in Argue, Patterson and Armstrong (1979) and in Armstrong and Argue (1977). In tables presenting pole seine, tow net and beach seine catches, coho are referred to as either coho fry or coho smolts, since these designations identify fish from separate brood years. "Grilse" chinook caught by purse seine were assumed to be age 0.1 and grilse coho were assumed to be age 1.1. Grilse have completed one winter in the ocean; they have been excluded from all analyses.

Data from field record sheets (catch by species, gear type, station and date) were entered and analysed using the spreadsheet program (Lotus 1-2-3™). A relational database management system (DBase III™) was used to store and analyse data from each sampled fish (stomach contents, size, tag code, recapture gear, date and station). 1973 stomach sample data were available only in summarized form (Dave Barrett, pers. comm.).

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1. The European method of age designation as recommended by Koo (1962) is used in this report; the number of winters the fish spent in freshwater is noted to the left of the dot and the number of winters the fish spent in saltwater is noted to the right of the dot.

2.6.1 Relative abundance and distribution

Catch per unit effort (CPUE) was assumed to measure changes in relative abundance of juveniles. The unit of effort was a single set of a particular sampling gear; sampling periods were either biweekly, monthly or bimonthly. Excluded from relative abundance analyses were recoveries of marks for which there was no sampling effort or unmarked catch data, and recoveries of fish that were coded-wire tagged at other locations.

For relative abundance analyses using CWTs, the numbers of recoveries of a particular code or group of codes was adjusted to a standard number of tag releases (25,000) to facilitate comparisons amongst tag codes. The adjusted number of recoveries was equal to CWT recoveries for a particular code(s) times 25,000 divided by the number of releases for the particular code(s).

The distributions of CWTs (unadjusted) were analysed using multi-way G-tests of independence (Sokal and Rohlf 1969).

2.6.2 Change in size

Regression analysis, analysis of variance and t-tests were used to compare lengths of marked chinook and coho amongst grouped sampling stations, sampling periods and locations of release (coho only). Fish in their first ocean year that were tagged at locations other than Cowichan-Koksilah (10 of 610 CWT recoveries) were included in most of the size analyses. Lengths from preserved fish were not corrected for the small amount of shrinkage (~3%) expected from preservation in formalin (Parker 1963).

2.6.3 Stomach contents

Four commonly used indices that provide information on predator feeding behavior were used in this study; numerical percentage, frequency of occurrence, weight percentage, and the index of relative importance (Pinkas, Oliphant and Iverson 1971). Table 4 presents definitions of each index. Stomach contents data in 1976 were compared between time periods and grouped sampling stations using these indices. All marked fish in their first ocean year were included in the 1976 analyses.

The 1973 stomach data were available for chinook and coho only in weight percentage for two week time periods and

groups of diet organisms, and in weight percentage for individual diet organisms summed over sampling periods. Samples taken by each gear type had been combined in the summary tables.

In 1976, wet weight of stomach contents was estimated from prey count and length measurement data. Regressions of prey length on prey wet weight were available for many of the diet items (Fulton 1968; and unpublished data from Bev Kask and Tom Brown, pers. comm.). Table 5 lists regression parameters for the equations that were used in this study to estimate weight of stomach contents. The numbers of each organism within one millimeter intervals of length were converted to wet weight using these formulae.

Some organisms were not represented by the available length-weight formulae and the following relationships were assumed for these organisms. Polychaetes were converted using a formula for "trochophore larvae and polychaetes". Regressions for mysids, copepods, isopods and euphausiids were assumed to apply to the individual species in these taxa. Two genera of hyperid amphipods (Primno and Hyperoche) and the category "unidentified hyperids" were converted to weights using the formula for Parathemisto, also a hyperid amphipod. Jassa, a genus of gammarid amphipod, was assumed to be represented by the formula for the gammarid Corophium. Caprellid amphipods are similar in morphology to hyperid amphipods, so caprellids were converted using the formula for Parathemisto. Megalops larvae of decapods were assumed to be represented by the formula for zoea larvae; however, it is noted that the morphologies of the two larval forms are very different. Three conversion formulae were available for insects: one formula for chironomid larvae and two formulae for insects of unspecified classification that were sampled in May and June. Regression parameters for the latter two formulae differed greatly: May, $a = 0.00469$, $b = 2.322$; June, $a = 0.222$, $b = 1.047$. The June formula was used since stomach samples in this study were collected from June onwards. Arachnids were converted to wet weight using the June insect formula.

Stomach contents were combined in two ways, by habitat and by taxonomic categories. The data for 1973 sampling periods were available only by habitat group (marine zooplankton, larval and juvenile fishes, estuarine benthic organisms, larvae of benthos, various eggs, insects). The 1973 diet items within these groups are listed in Appendix Table 37. To allow comparison of 1973 and 1976 data, 1976 data were organized by habitat group (Appendix Table 38). 1976 data were also analyzed by taxonomic group (polychaetes, copepods, amphipods, euphausiids, decapods, insects, herring).

3.0 RESULTS

3.1 Total Catch

A total of 12,007 chinook and 7,659 coho were captured on the Cowichan estuary and in Cowichan Bay during three years of sampling (Table 6). Most of these (~99%) were juveniles in their first ocean year. Four percent of the coho were fry and 95 percent were smolts. Pole seining on the estuary flat produced the lowest catches (2 chinook juveniles and 24 coho fry); purse seining at the head and edges of the bay accounted for 91 percent of the total catch (10,782 chinook and 7,107 coho). Appendix Tables 1 to 17 present the daily catch results for each species, gear type, station and year. An additional 1,180 chinook and 1,750 coho (99% first ocean year fish) were captured by purse seine at stations outside Cowichan Bay in 1975 and 1976. Appendix Tables 18 and 19 present these daily catch results.

Table 7 shows the catch in Cowichan Bay of species other than chinook and coho salmon. Twenty-seven species were identified from sampling hauls for which field records were available. Pacific herring accounted for 90 percent of the non-salmon catch; most herring were taken by purse seine. Other common species were chum salmon fry, threespine stickleback and shiner perch.

3.2 Recovery of Marked Fish

During 1975 and 1976 sampling years, 8,517 chinook and 6,155 coho were examined for missing adipose fins (marked fish) (Table 8). Seine gear accounted for 723 of a total of 730 mark recaptures. Table 8 excludes fish in their second ocean year and marked fish for which field records were missing.

In 1975, field crews returned only a portion (78%) of the catch of marked fish to the laboratory for examination for coded-wire tags. In 1976, all marked fish were supposed to have been returned to the laboratory, however, laboratory records could not be located for seven marked coho and one marked chinook that were recorded on the field sheets (see footnotes to Appendix Tables 8, 17 and 19).

Table 8 presents the percentages of marks returned to the laboratory and that were found to have tags. Overall, 92 percent of adipose clipped chinook and 86 percent of adipose clipped coho contained coded-wire tags. Tags from stocks other than Cowichan (Table 9) accounted for less than three percent of first ocean year chinook and coho that carried CWTs.

3.2.1 Chinook

Appendix Tables 20 and 21 list recovery information (tag code, station, date, fork length and wet weight) for 1975 and 1976 chinook mark recoveries. The appendix tables include tagged chinook additional to the 297 chinook with CWTs noted in Table 8. The additional fish were either from different brood years, or were fish for which field records of catch and effort had been lost.

Two chinook, recaptured in 1975, apparently carried coho tags. They have been treated as tagged 1974 brood chinook in all analyses on the basis of their small size at time of recapture, and their identification as chinooks by the field crew.

The seven chinook CWTs listed in Table 9 were the only recoveries of non-study area chinook during 1975 and 1976 surveys. Tag codes for most of these fish were not available from laboratory records, but tagging locations and additional tag release information were usually recorded. The chinooks released from Portage Bay Washington and from Capilano hatchery that were recovered in May and June of 1975, were assumed to be age 0.1 fish from the 1973 brood year on the basis of their relatively large size at time of recapture (>300 mm). The Deschutes Washington fish that was 234 mm when recovered on 5 July 1976 was recorded on the laboratory records as being from the 1974 brood, and so was also assumed to be age 0.1. Two chinook contained either misread or unknown tag codes (the laboratory records contained a question mark next to the tag codes). The chinook that was recovered on 20 August 1976 was apparently carrying a tag code for chinook released from Capilano hatchery in June 1973. However, the recapture size of this fish was too small for it to have been from the 1972 brood; more likely the CWT was misread. Thus, of the seven recoveries of non-study area chinook, only the Capilano hatchery chinook released on 17 June and recovered on 1 October appears to have migrated to Cowichan Bay within six months of release.

3.2.2 Coho

Appendix Tables 22 and 23 list the 1975 and 1976 coho mark recoveries. Appendix Table 23 includes 17 coded-wire tagged coho additional to the total of 230 CWTs noted in Table 8. There were no field records of catch and effort for these 17 fish.

All of the coho recovered in 1975 and 1976 with non-study area tags were likely age 1. coho from 1973 and 1974 brood years

based on their size at recapture (Table 9). Four of the eight non-study area fish would appear to have migrated to Cowichan Bay from northern Puget Sound hatcheries within three months of release. The Capilano fish that was recovered in Maple Bay (station B10) on 23 May was apparently part of a tagged group that was released one year earlier in June 1974. The remaining three non-study area coho were recovered outside Cowichan Bay within three months of release.

Non-study area coho accounted for 1.9 percent of the age 1. coho with CWTs caught in Cowichan Bay, and 3.0 percent of the age 1. cohos with CWTs caught outside Cowichan Bay.

3.3 Survival of CWT Fish

Table 10 presents preliminary estimates of commercial and recreational catch (Margaret Birch, pers. comm.), escapement (Lister, Thorson and Wallace 1979), and survival from release to catch and escapement, for selected groups of tagged coho and for both groups of tagged chinook. These data are presented to assist with interpretation of relative abundance data.

The lower river mark group under the heading "Location of Release" includes coho smolts tagged at Rotary Park on the Cowichan River, and at Kelvin Creek on the Koksilah River. These tagging locations were within five kilometers of the Cowichan estuary. The upper river group includes releases from Mesachie Creek which drains into Cowichan Lake and is approximately 50 km upriver from the estuary. Lower and upper river releases were divided into early and late release groups, that is releases before and after approximately May 22. Further tag release information is presented in Table 3. In Table 10 the estimated number of mark releases that carried adipose clips and CWTs (Ad-CWT) was obtained by multiplying the numbers of marks released by the estimates of tag retention obtained from returning adults captured by purse seine in Cowichan Bay (Lister, Thorson and Wallace 1981). Their estimates took into account fish that lost their adipose fin from natural causes, and the 20 day period after tagging when 90 percent of tag loss is thought to occur (Blankenship 1981).

In 1975, the highest survival rate to catch and escapement, 23.5 percent, was for lower river coho smolts released with CWTs early in 1975. Based on Chi-square, these coho smolts survived at a higher rate ($P<0.01$) than did the late release coho smolts (19.6%) from the lower Cowichan.

In 1976, survival rates for late and early release coho from lower river sites did not differ ($P>0.05$), but early release

smolts from upriver sites had significantly ($P<0.01$) higher survival (11.9%) than did late release smolts (8.3%) from upriver sites. Lower river coho smolts survived at a higher rate overall (13.6%) than did upper river smolts (10.8%) ($P<0.01$).

Lower river coho smolts marked in 1975 had a higher ($P<0.01$) survival (21.1%) than did lower river coho smolts marked in 1976 (13.6%).

CWT chinook had much lower survival to catch and escapement than did CWT coho. Survival was similar for releases in 1975 and 1976 (6.0% for 1974 brood and 6.1% for 1975 brood).

3.4 Juvenile Chinook

3.4.1 Distribution and Timing

3.4.1.1 Estuary flat

Juvenile chinook were caught by beach seine at stations on the estuary flat from April through to the last two weeks of July (Table 11). Peak catch per set occurred during the first two weeks of June. Juvenile chinook were caught by tow net in the estuary channels and just seaward of the dropoff from mid May through to the end of sampling on 7 August (Appendix Table 2). Highest tow net catches occurred on June 11 and catches at station 4 remained high until the end of sampling. Movement of juvenile chinook from the estuary flat to intertidal areas around the edges of Cowichan Bay did not take place until June, based on beach seine CPUE (Table 11).

3.4.1.2 Head, edge and outside Cowichan Bay

Tables 12 and 13 present chinook CPUE by purse seine, by two week interval, for head of Cowichan Bay, edge of Cowichan Bay, and outside Cowichan Bay stations (see Figures 3 and 4 for station locations). Figure 7 presents bi-weekly catch per set data for each area and year.

Chinook CPUE peaked during the last two weeks of June in 1975 at head (125/set) and edge (40/set) of bay stations. In 1973, when only head of bay stations were sampled by purse seine, peak CPUE was much higher (356/set) and occurred during the first two weeks of July. High CPUE (39-131/set) continued in 1973 through the first two weeks in September.

In 1976, chinook CPUE was much lower than in 1973 and 1975; as well, peak CPUE (43/set) did not occur at the head of

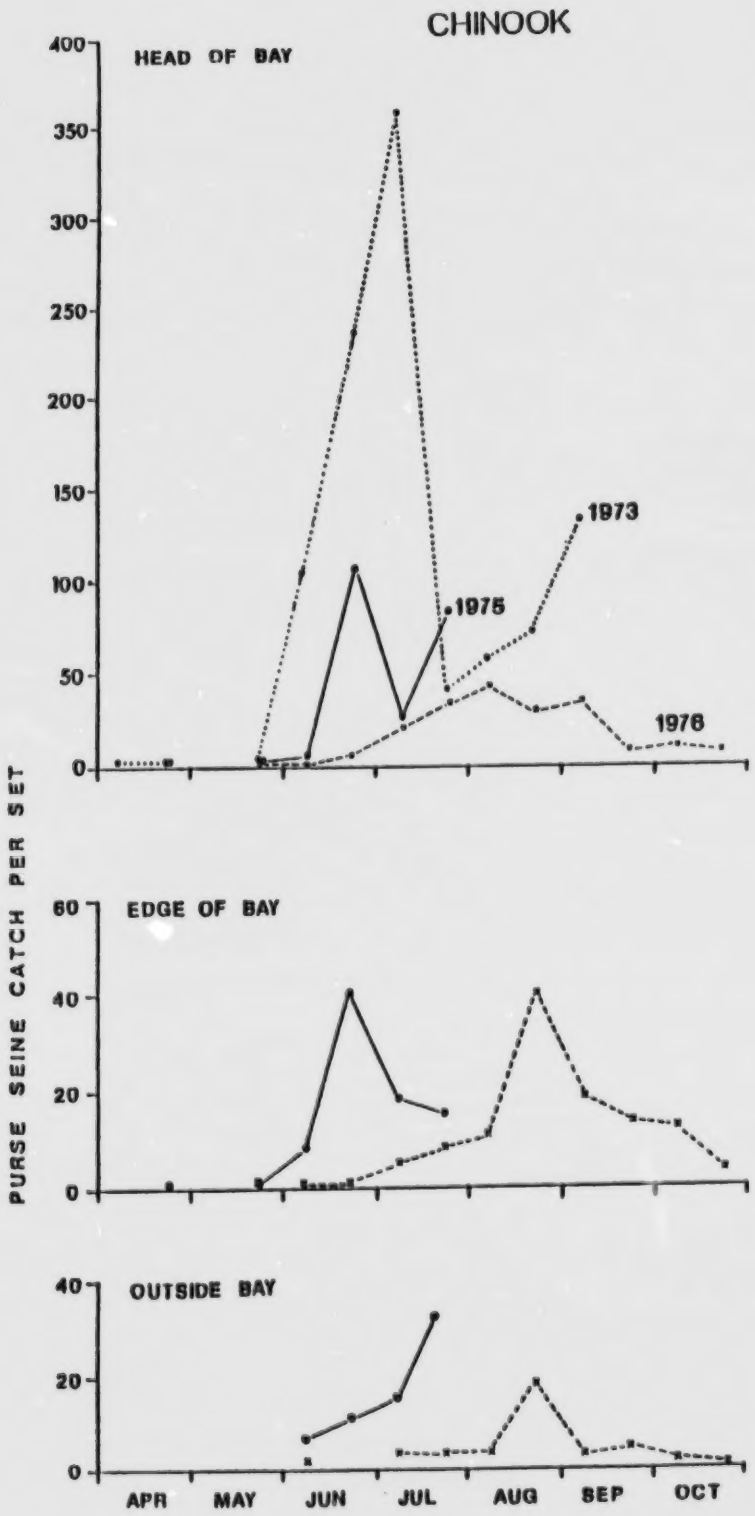

Fig. 7. Chinook catch per purse seine set at head, edge and outside Cowichan Bay stations, 1975 and 1976.

the bay until the first two weeks of August, and did not occur along the edges of the bay (40/set) until the last two weeks of August. Chinook were not common at head of bay stations in 1976 until the first week in July. Catch per set gradually declined after the peak in August to reach low values (<10/set) by late October.

Chinook CPUE for stations outside Cowichan Bay in 1975 and 1976 was less than one-half of that measured for head of bay stations. At head of bay stations, chinook CPUE was about twice as high as that at edge of bay stations in both years, and was always low at the middle bay stations (Tables 12 and 13).

The higher apparent abundance of juvenile chinook in 1975 compared to 1976 was not reflected in the escapement of adults in the brood year (Table 14). However, there was a large flood during the late fall of 1975 (see discharge data in Table 14), and this may have killed many chinook eggs. Chinook escapement was highest in 1972 and abundance of juveniles, as indexed by purse seine CPUE, was highest in 1973.

3.4.1.3 Distribution of unmarked and marked fish

Marking began in mid-June in 1975 and 1976 at a site near purse seine station six. One-half of the marks were released by June 27 in 1975, and by June 29 in 1976; marking was complete by July 2 in 1975 and by July 14 in 1976 (Armstrong and Argue 1977; Argue, Patterson and Armstrong 1979). Similar numbers of chinook were marked in both years.

In 1975, marked chinook accounted for less than one percent of the purse seine catch inside Cowichan Bay (Table 15), and were not found on the estuary flat amongst 695 juveniles captured by beach seine. In 1976, marked chinook accounted for 7.3 percent of the Cowichan Bay purse seine catch. Figure 8 presents the biweekly percentages of adipose clipped chinook in the catch. In 1976, after the last week of June, the percentage of the catch that was marked scarcely changed until the project terminated in late October. Marks were most prevalent in catches from stations near the marking site (Table 15).

Table 16 presents the percentage of marks in the catch for grouped sampling stations and two week periods. In 1976, the percentage of marks at edge of bay stations remained below that for head of bay stations until September.

It was of interest to further examine the data to test the assumption that marks were randomly distributed amongst the total juvenile population. This was carried out as follows.

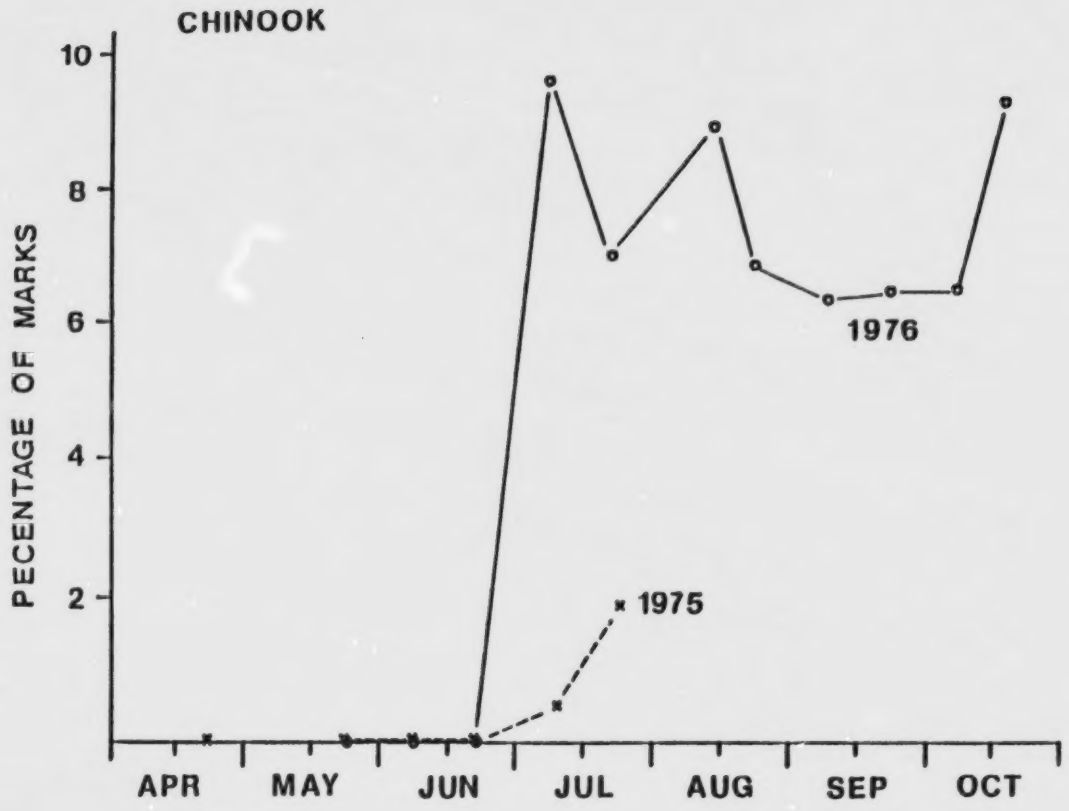

Fig. 8. Percentage of adipose clipped chinook in the purse seine catch inside (head, edge and middle of Bay stations) Cowichan Bay. Biweekly sample sizes exceeded 150 from July 1 to the end of October.

Figure 9 contrasts the CPUE for unmarked and CWT chinook caught in July 1975 and July 1976 inside Cowichan Bay (data from Appendix Tables 24 and 25). Relative abundance of CWTs was highest in 1976, whereas relative abundance of unmarked chinooks was lowest in 1976. Since CWT recoveries in both years were adjusted to a standard number of releases (Section 2.6.1), the discrepancy suggests that CWT chinook tended to linger in Cowichan Bay in 1976, or that the 1976 CWT chinook experienced higher survival immediately after marking than did the 1975 CWT chinook. The latter explanation does not appear to be the case since smolt-to-adult survival was similar for the two brood years (Table 10). If CWT chinook lingered in the Bay in 1976, it is possible that they were behaving differently from unmarked chinook and hence were not randomly distributed amongst the total juvenile chinook population.

Table 17 presents the percentages of the July catch of chinook containing CWTs at head, edge and outside Cowichan Bay stations. Differences in the proportions of CWT chinook, between years and grouped stations, was tested using a three-way G-test of independence. Stations and years differed significantly ($P<0.01$); however, partitioning of the data showed that the proportion of marks was independent of station in 1975, but not in 1976 ($P<0.01$), indicating that there was clumping of CWTs at the head of Cowichan Bay in July 1976.

The 1976 data were examined in more detail as presented in Table 18. The same G-test showed that the proportion of marks was independent of bimonthly period, but not of station ($P<0.01$). Comparing just the head and edge stations, the proportion of marks was independent of station in September-October, but not in July-August ($P<0.01$) (data from Appendix Table 26). On the basis of these results it is concluded that marks in 1976 were not distributed evenly amongst the total chinook population until the September-October period. Figure 10 illustrates these results.

3.4.2 Change in size

Figure 11 presents average lengths and two standard errors about the averages, by two week intervals, for coded-wire tagged chinook released in 1975 and 1976 from the Cowichan estuary site and recovered in Cowichan Bay. Included on the graphs are the average lengths of juveniles at time of marking (points nearest the ordinate). Chinook were significantly smaller at time of tagging in 1975 compared to 1976, and this difference continued for the next two biweekly periods. In 1976, the rate of increase in length appeared to decrease late in the sampling period. The slope of a linear regression of average length on

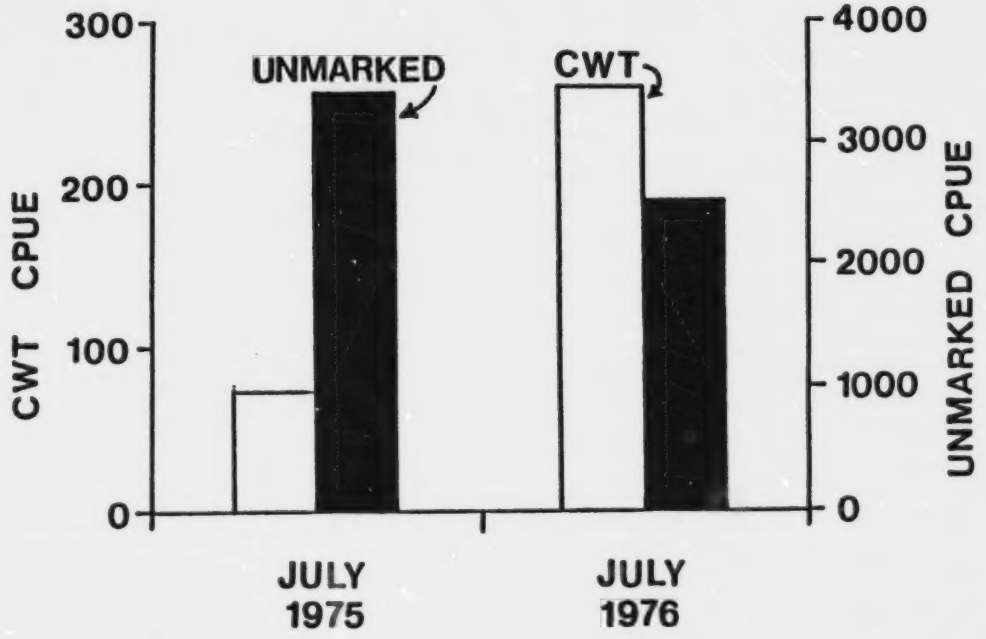

Fig. 9. Comparison of chinook catch per 100 purse seine sets (CPUE) between CWT and unmarked chinook caught inside Cowichan Bay in July 1975 and July 1976. CWT CPUE has been adjusted to a standard number of releases.

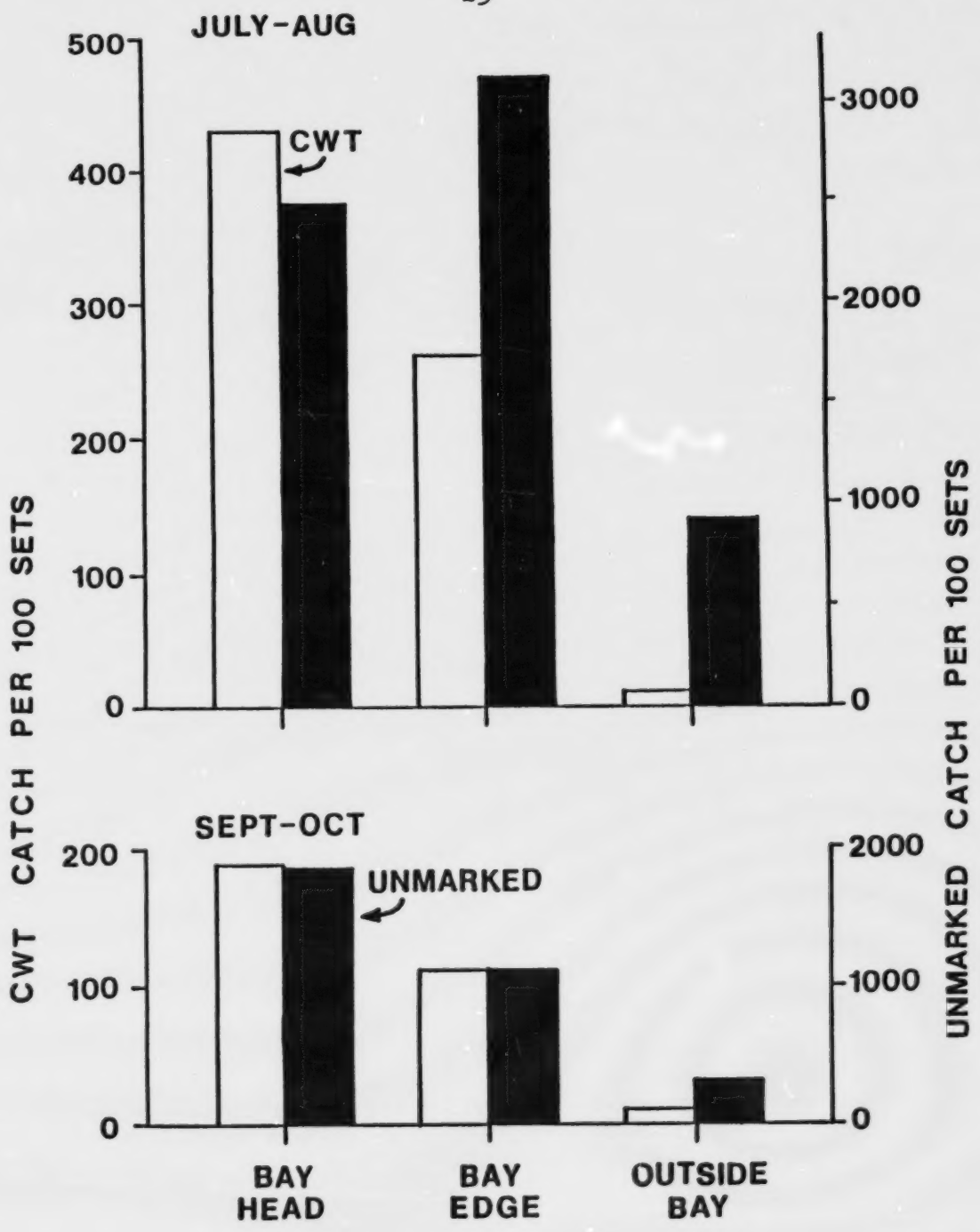

Fig. 10. Comparison of 1976 chinook catch per 100 purse seine sets (CPUE) between CWT and unmarked chinook caught at head, edge and outside Cowichan Bay stations. CWT CPUE has been adjusted to a standard number of tag releases.

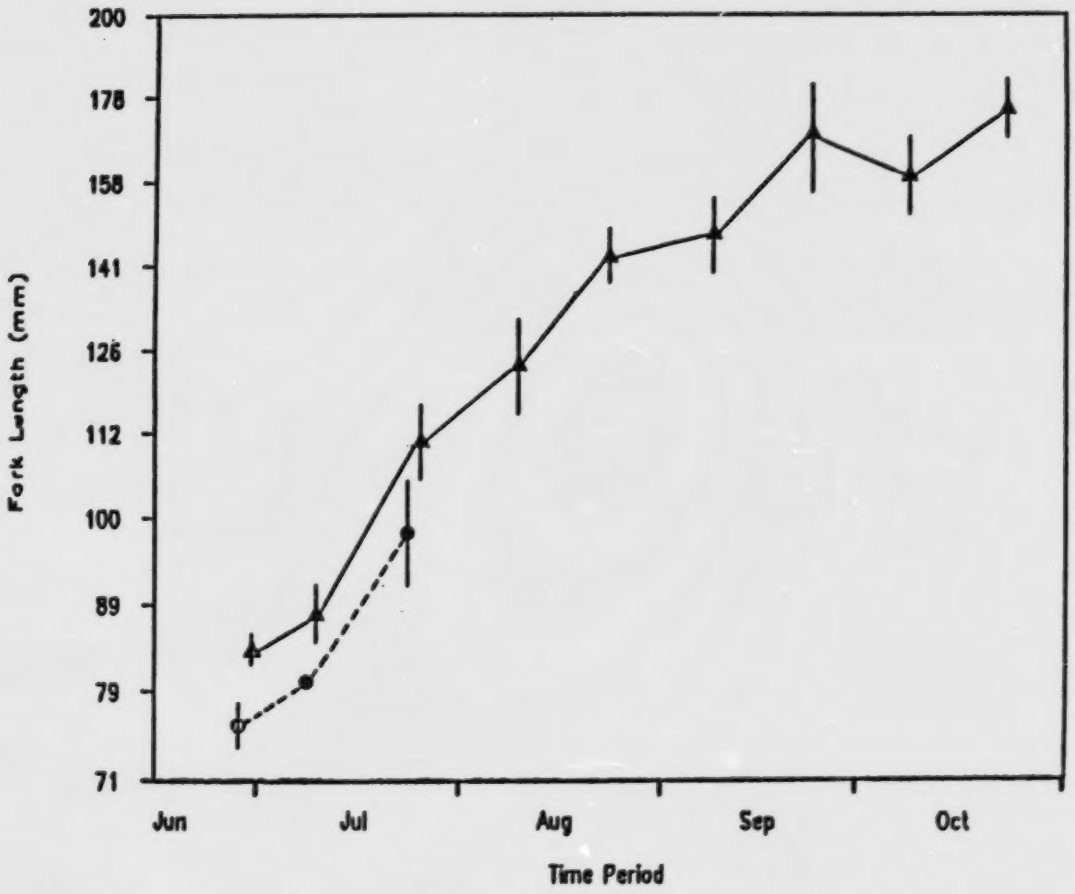

Fig. 11. Average fork length (mm) of marked chinook, by two week interval, captured inside Cowichan Bay by purse seine in 1975 (circles) and 1976 (triangles). The bars represent two standard errors about the means. The open symbols represent average size of marked chinook juveniles at time of release. The ordinate is in log scale but hash marks are at even intervals. Data from Appendix Table 33.

Julian date (mid point of the 1976 sample period) was 0.97 mm per day (R^2=0.98). October samples were excluded from the regression.

Figure 12 shows average lengths and two standard errors about the averages for CWT chinook caught at head and edge of bay stations in 1976 (Appendix Table 33 contains the basic data). Chinook caught at head of bay stations were smaller than chinook from edge of bay stations in six of seven two week periods; however, in all cases the standard errors overlapped as sample sizes were quite small. A paired sample t-test using equal numbers of head and edge samples from each sample day (51 pairs of observations) showed that chinook captured along the edges of Cowichan Bay were significantly ($P<0.01$) larger (mean 143 mm) than chinook captured at the head of the bay (131 mm). There were insufficient CWT chinook from outside Cowichan Bay stations for statistical analysis.

3.5 Juvenile Coho Salmon

3.5.1 Distribution and timing

3.5.1.1 Estuary flat

In 1973, coho fry were first caught on the estuary flat by beach seine during early April (Table 19). Peak catch of fry occurred in late May. Fry catches by beach seine were negligible in 1975. Pole seine and tow net catches of fry in intertidal flood channels were also highest between late May and early June in 1973 (Appendix Tables 10 and 11). Tow net catches of fry along the estuary dropoff were highest during the first two weeks of June. Coho fry were seldom caught at beach seine stations along the edges of Cowichan Bay, or at estuary flat stations after mid-July.

Coho smolts were not caught by pole seine and did not occur in tow net or beach seine catches until the first two weeks of May (Appendix Tables 10 and 11, Table 20). Peak smolt catches on the estuary flat coincided with peak downstream migration of smolts during the last two weeks of May (Armstrong and Argue 1977; Argue, Patterson and Armstrong 1979). Based on CPUE, coho smolts appeared much less abundant on the estuary flat than did coho fry and juvenile chinook.

3.5.1.2 Head, edge and outside Cowichan Bay

Coho fry were not caught by purse seine.

Tables 21 and 22 present the catch of coho smolts per set and the number of sets, by two week period, for grouped head,

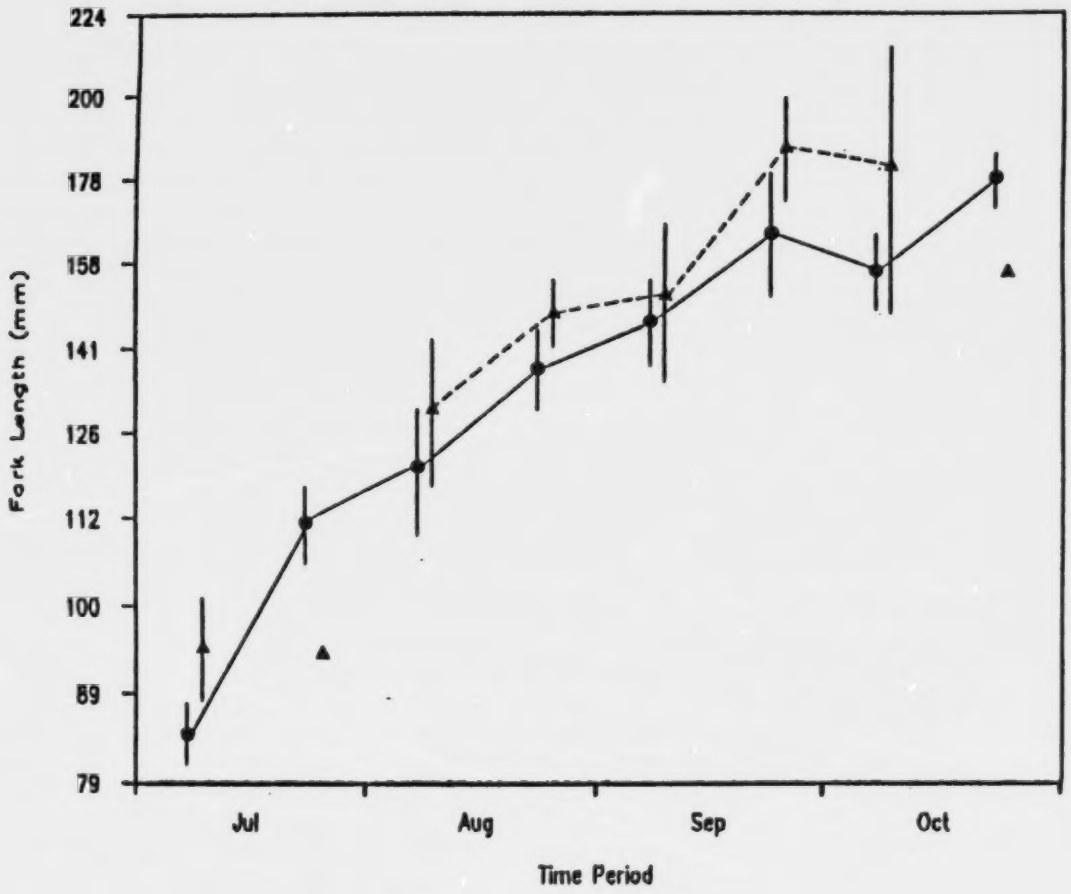

Fig. 12. Average fork lendgth (mm) of marked chinook captured by purse seine at the head (circles) and edge (triangles) of Cowichan Bay in 1976. The bars represent two standard errors about the means. The ordinate is in log scale but hash marks are at even intervals. Data from Appendix Table 33.

edge and outside Cowichan Bay stations. Figure 13 graphs the catch per set data.

Relative abundance of coho smolts was highest in 1973, intermediate in 1975, and lowest in 1976. In 1973, peak CPUE occurred during the last two weeks of June at head of bay stations. In 1975, peak CPUE (78/set) occurred during the last sampling period (July 16-31) and was three times higher than during the comparable period in 1976 (24/set), but was lower than during the comparable period in 1973 (104/set). In 1976, peak CPUE occurred during late July at head of bay stations, and during late August at edge and outside bay stations.

Catch per set at outside bay stations was lower than CPUE at inside bay stations in 1975 and was somewhat higher than inside CPUE in 1976. Coho CPUE was usually slightly higher at head of bay stations than at edge of bay stations. Very few coho were caught at stations in the middle of Cowichan Bay (Tables 21 and 22).

The high apparent abundance of 1971 brood coho smolts in 1973 may reflect the large escapement of coho in 1971 (Table 23). However, the estimated coho escapement in 1974 was similar to that in 1971, but relative abundance of smolts in 1976, as measured by purse seine CPUE, was much less than in 1973. The higher apparent abundance of 1973 brood coho smolts in 1975 as compared to 1974 brood smolts in 1976 also does not appear related to escapements (Table 23).

Smolt density at freshwater trapping sites was approximately twice as high in 1975 compared to 1976. This is consistent with the observation of higher apparent abundance of smolts in Cowichan Bay in 1975.

Smolt production has been shown to be inversely related to minimum stream flows during the summer that coho fry rear in freshwater (Smoker 1953). However, this relationship does little to explain differences in purse seine CPUE amongst study years since minimum summer stream flows were lowest for 1971 and 1973 brood coho (Table 23), and both broods produced high purse seine CPUEs. Clearly there must be factors other than escapement and freshwater rearing conditions that influence abundance of coho smolts in Cowichan Bay.

3.5.1.3 Distribution of unmarked and marked fish

Coho smolts were marked from mid April to mid June at five sites on the Cowichan River and at one site on the Koksilah River (Figure 2). The date on which one-half of the smolt migration occurred was May 22 at Rotary Park and Mesachie Creek

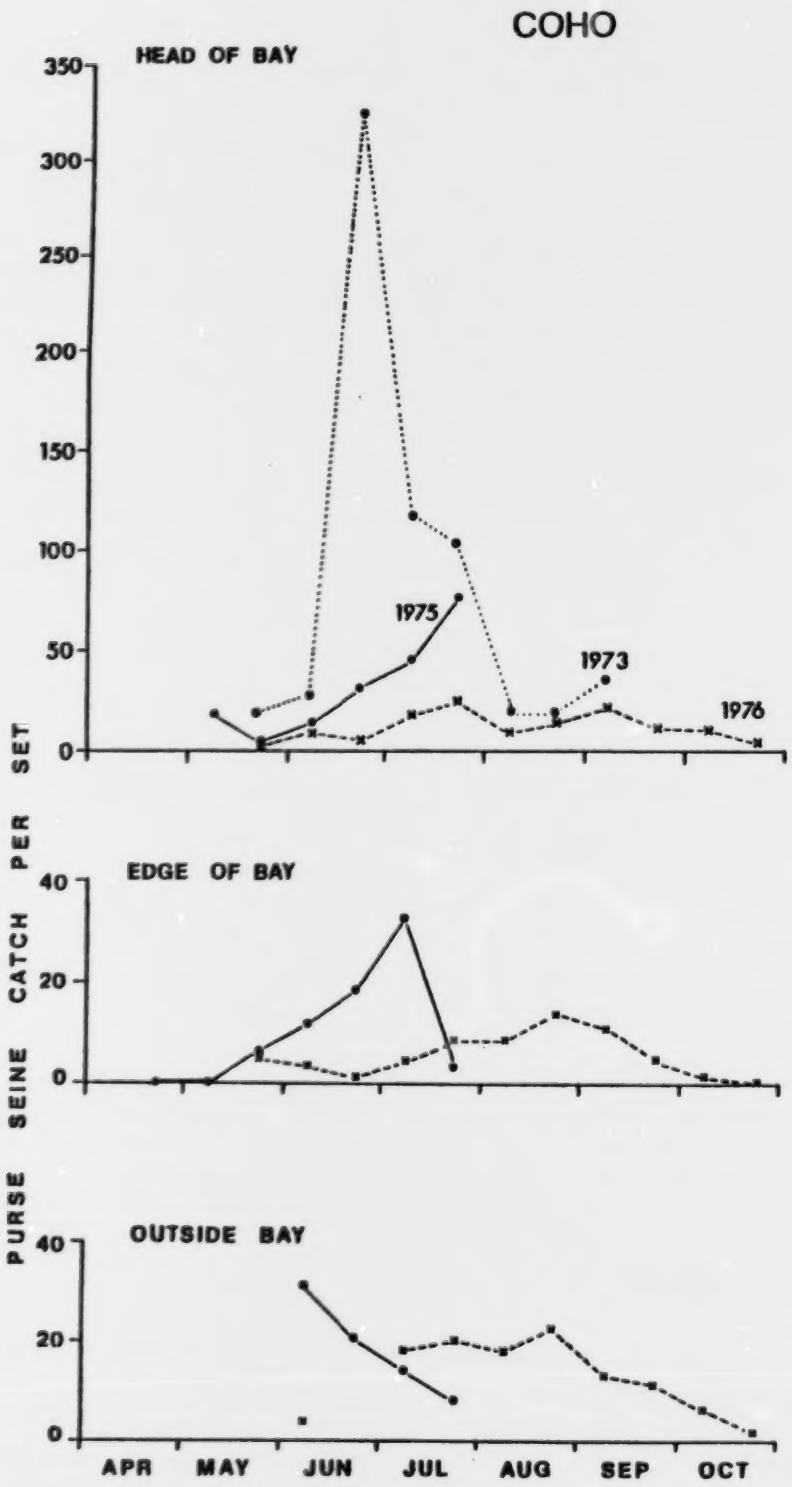

Fig. 13. Coho catch per purse seine set at head, edge and outside Cowichan Bay stations, 1975 and 1976.

sites, and May 18 at the Kelvin Creek site. These were also the dates by which 50 percent of the marks had been released. Marks released before the migration peak were designated early releases, and those released after the peak were designated late releases.

The percentage of marked coho in the purse seine catch is graphed for inside and outside Cowichan Bay stations in Figure 14 (data from Table 24). Marks made up between 3.5 and 6.5 percent of the catch at both locations in 1975, and between 6 and 12 percent of the catch from July through October in 1976. The percentage of marks in the catch varied among time periods, but was without an obvious trend. The high percentage of marks in the catch at outside stations in late August 1976 was the result of one set at a station in Maple Bay. Disregarding this set reduced the August 16-31 percentage from 12.2 to 8.2, which is similar to the other percentages for outside stations. Within Cowichan Bay, marks appeared to be quite evenly distributed amongst the individual stations (Table 25).

In July 1975, CWT coho and unmarked coho appeared to be much more abundant (high CPUE) at the head of the bay than at the edges of the bay compared to July 1976 (Figure 15). Based on a G-test of independence, the proportion of CWTs in the 1975 and 1976 catches (Table 26) did not differ significantly amongst stations (data from Appendix Tables 27-29 and 31). These results indicate that marked coho were randomly mixed with unmarked coho in July, and the CPUE results suggest that coho were more abundant at the head of the bay in 1975 than in 1976.

Figure 16 presents the same type of CPUE information that was presented in Figure 15, but for bimonthly periods in 1976 (July-August, September-October) (data from Appendix Tables 30 and 32). The percentage of marks in the catch at grouped stations for these periods is given in Table 27. Based on a G-test of independence, there again were no differences in the percentages of marks amongst stations or time periods. High CPUE for CWT and unmarked coho during July-August for edge and outside stations, compared to head stations, suggests that coho were dispersing from Cowichan Bay at this time. Coho that remained in the bay during September-October appeared to be more abundant at head of bay stations than at edge of bay stations.

Figure 17 presents July-August and September-October CPUE for early and late releases of 1976 coho smolts from upper and lower river sites. Survivals to catch and escapement are presented under captions on the abscissa. Several features are of interest. First, CPUE for late release coho was higher than CPUE for early release coho. This suggests that late release coho either survived at a higher rate than early release coho or

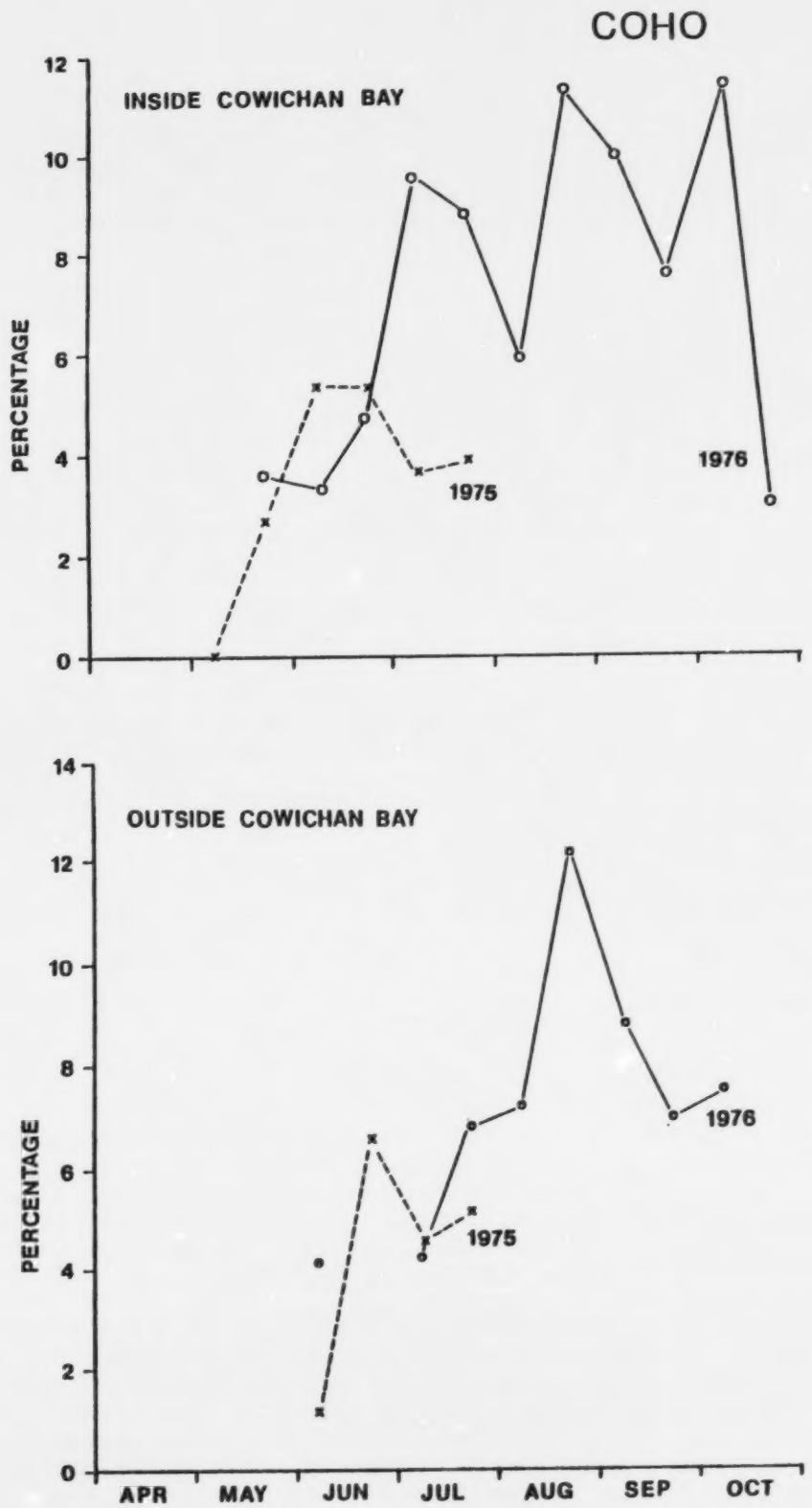

Fig. 14. Percentage of adipose clipped coho in the purse seine catch inside and outside Cowichan Bay. Biweekly sample sizes exceeded 100 in most weeks.

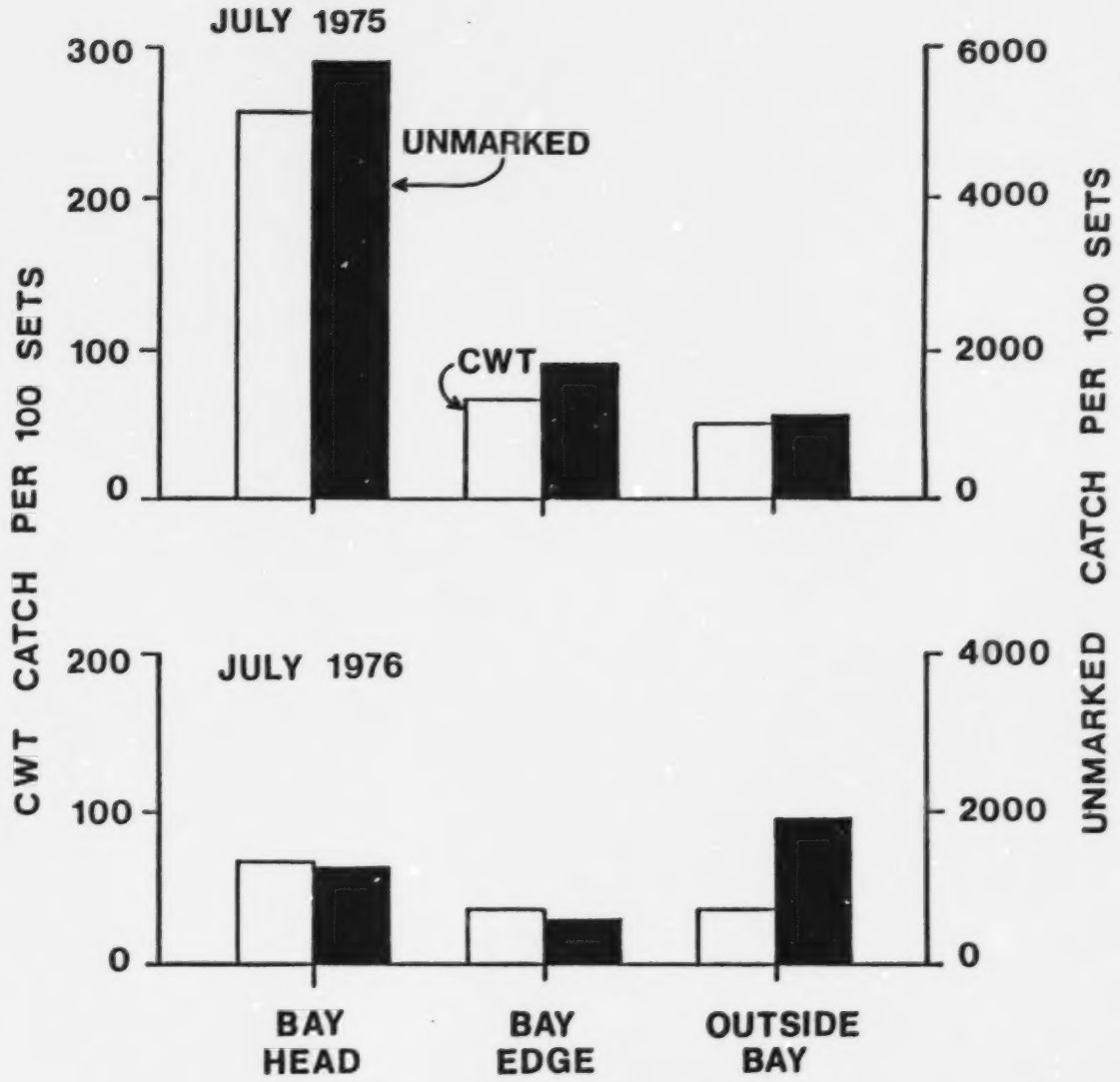

Fig. 15. Comparison of coho catch per 100 purse seine sets (CPUE) between lower river CWT coho and unmarked coho for head, edge and outside Cowichan Bay stations in July 1975 and July 1976. CWT CPUE has been adjusted to a standard number of tag releases.

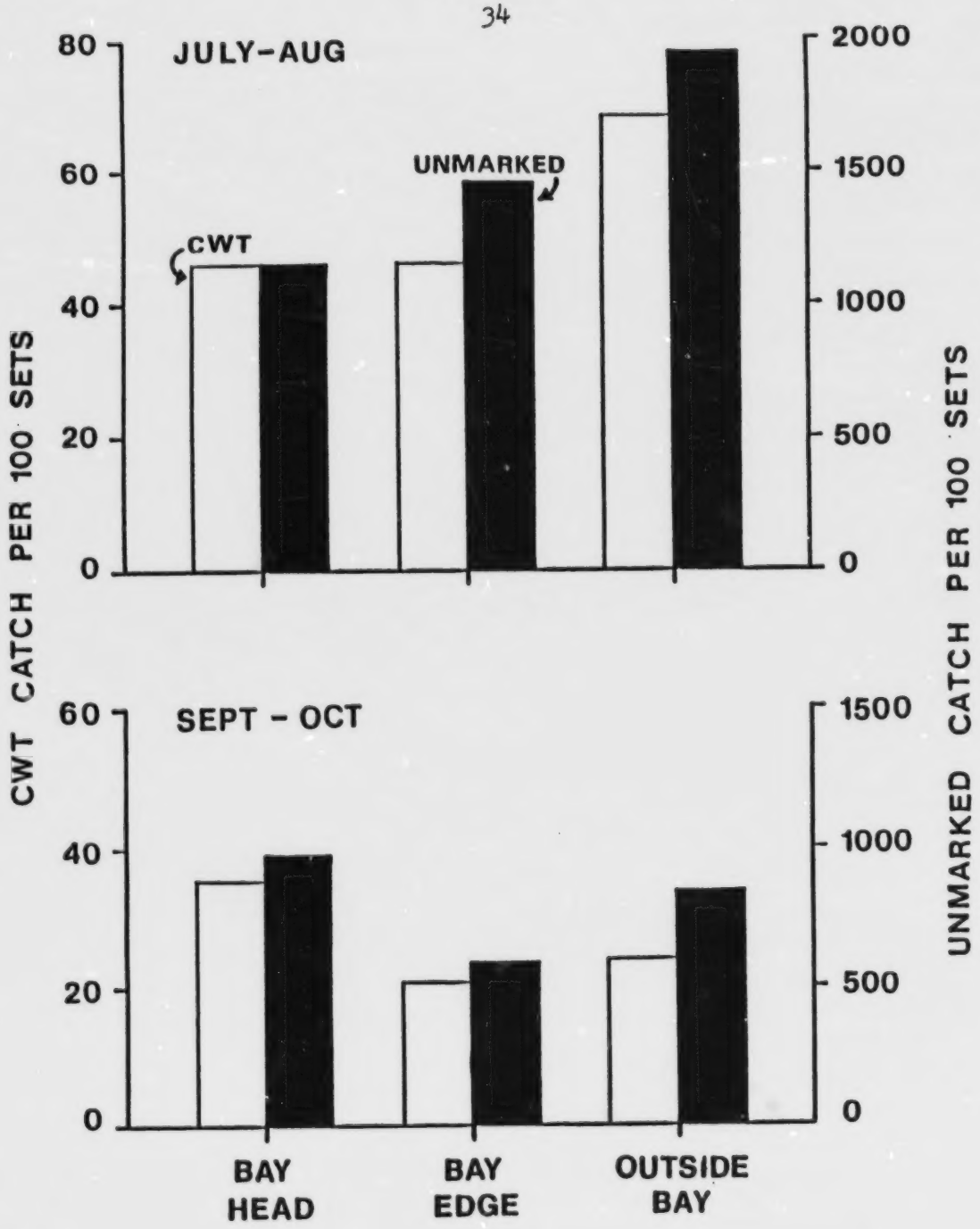

Fig. 16. Comparison of 1976 coho catch per 100 purse seine sets (CPUE) between lower river CWT coho and unmarked coho for all head, edge and outside Cowichan Bay stations. CWT CPUE has been adjusted to a standard number of tag releases.

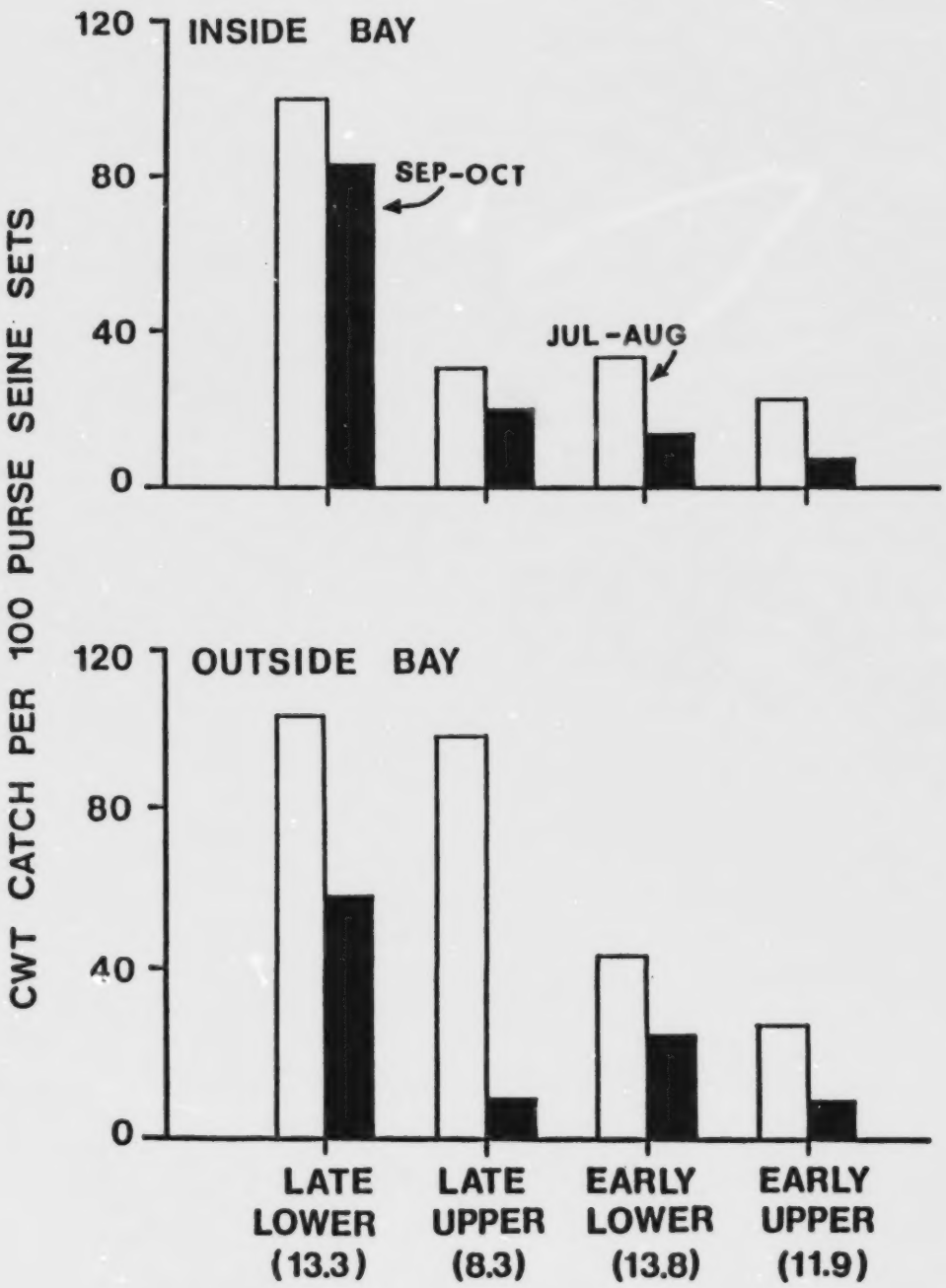

Fig. 17. Comparison of 1976 catch per 100 purse seine sets (CPUE) amongst upper and lower river, early and late releases of CWT coho. Percentage survival of marks to catch and escapement is presented under group captions. CWT CPUE has been adjusted to a standard number of tag releases.

tended to stay longer in Cowichan Bay. Since late and early release coho had similar smolt-to-adult survival (Table 10), it is more likely that late release coho lingered in Cowichan Bay. Second, late release coho from lower river sites were the most abundant of the four groups at all locations and during all time periods. Early release coho from lower river sites and late release coho from upper river sites had similar, intermediate CPUE levels. The least abundant group at inside and outside Cowichan Bay stations was the early release, upper river group. The percentage of tags from each group that were recovered inside Cowichan Bay (Table 28) did not differ significantly. Recoveries for early and late releases of lower river coho in 1975 produced similar results.

It is difficult to generalize about upper and lower river groups since the higher apparent abundance of lower river coho could have resulted from higher smolt survival (see Figure 17). However, in relation to time of release, these results suggest that early coho migrants spend less time in Cowichan Bay than late migrants and thus are least likely to be found in Cowichan Bay during summer months.

3.5.2 Change in size

Figure 18 presents average lengths, by two week intervals, for marked coho recovered in Cowichan Bay (data from Appendix Tables 34 and 35). Included on the graph are average lengths of juveniles at time of marking. The lengths at time of marking (50 percent mark release date) represent averages for individual marked groups, weighted by the number of marks released.

Coded-wire tagged fish were larger at time of release in 1976 than in 1975; however by July, 1975 CWT coho were larger than 1976 CWT coho. The rate of increase in coho length had slowed by October. The slopes of linear regressions of average length on Julian date were 1.22 and 0.99 mm per day for 1975 (R^2=0.91) and 1976 (R^2=0.98) respectively. The slopes were not significantly different. October samples were excluded from the 1976 regression.

Figure 19 presents regressions of coho fork length on Julian date for marked coho caught inside and outside Cowichan Bay. The slopes of the regressions were not significantly different, but the intercepts differed significantly ($P<0.01$). These results suggest that smaller Cowichan coho reside in Cowichan Bay.

Results in Section 3.5.1.3 suggested that coho that

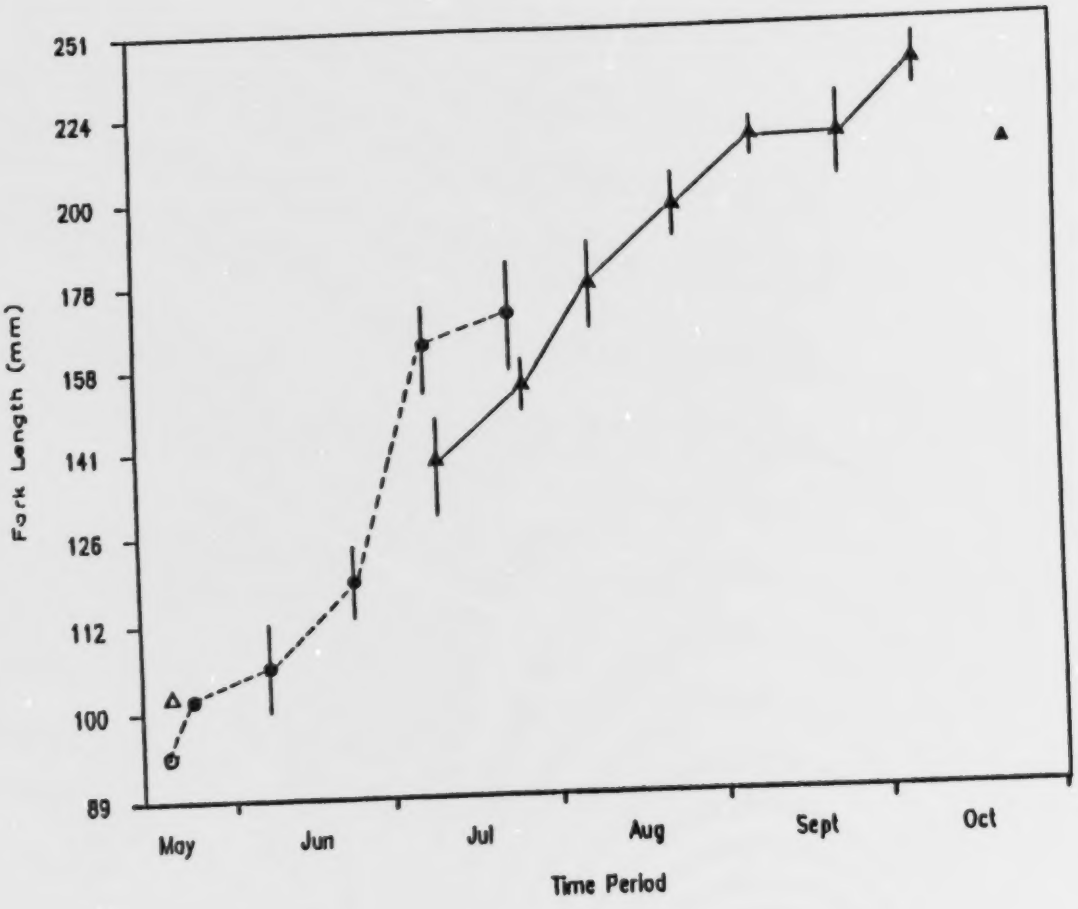

Fig. 18. Average fork length (mm) of marked coho, by two week interval for coho captured inside Cowichan Bay by purse seine in 1975 (circles) and 1976 (triangles). The bars represent two standard errors about the means. The open symbols represent the average size of marked coho smolts at time of release. The ordinate is in log scale but hash marks are at even intervals. Data from Appendix Tables 34 and 35.

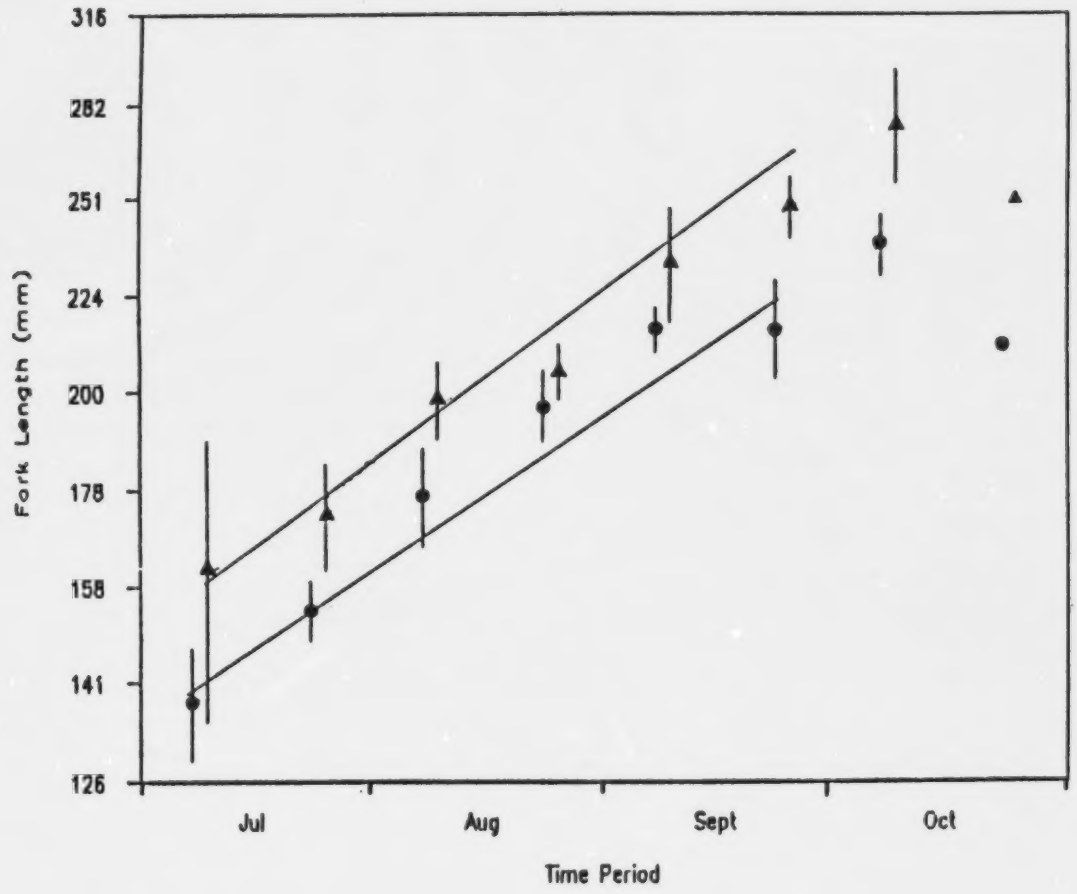

Fig. 19. Fork length (mm) of marked coho captured inside (circles) and outside (triangles) of Cowichan Bay in 1976. The bars represent two standard errors about the means. The linear regression equation for coho captured outside the bay (upper line) was Y=-59.49 + 1.15X; the equation for coho captured inside the bay (lower line) was Y=-66.44 + 1.09X. The ordinate is in log scale but hash marks are at even intervals. Data from Appendix Table 35.

migrated earliest from freshwater were least abundant during summer months in Cowichan Bay. It was of interest to see if there were differences in size of early and late migrants at time of recapture in Cowichan Bay, since early and late migrants left freshwater at similar sizes (Table 3). Two-way analyses of variance were used to test the hypothesis that early and late release smolts were the same size on recapture in Cowichan Bay. Data for these analyses are contained in Appendix Table 36. There were enough recoveries of Rotary Park and Mesachie Creek coho to complete three balanced analyses. Biweekly recovery periods and release times were levels in the analyses. In two analyses for July, coho released early were significantly ($P<0.05$) larger at recapture than late release coho. Size at recapture for early and late release coho were not significantly different for the August 16 to September 15 recovery period. These results suggest that any growth advantage conferred by early migration diminished through the summer. In Table 29 it can be seen that on return to Cowichan Bay, adult coho from early releases tended to be larger than late release coho, however these differences in average size were not statistically significant.

3.6 Stomach Contents

3.6.1 Total data set

Tables 30 to 35 summarize the stomach contents of juvenile chinook and coho.

Table 30 (chinook) and Table 33 (coho) list the individual diet items in 1973 in order of weight percentage (1973 data available only in this form). There were 25 items identified from the stomachs of chinook and 19 items identified from the stomachs of coho. Juvenile Pacific herring (*Clupea harengus pallasi*) dominated the stomach contents of both species. Juvenile herring were also caught in most of the purse seine sets. The remaining diet organisms, with few exceptions, were invertebrates.

Tables 31 and 34 present the individual diet items from chinook and coho stomachs in 1976 in order of frequency of occurrence. There were 55 items identified from the stomachs of chinook and 27 items identified from the stomachs of coho. Herring were the most frequently encountered item. Tables 32 and 35 present the total numbers of each prey item that were counted from the stomachs of chinook and coho in 1976. Zoea larvae of decapods were by far the most numerous item in the stomachs of both species. Most were larvae of porcellanid crabs which are common to estuaries and intertidal zones (Anon 1980).

Polychaetes were the second most common organism in chinook stomachs.

Some of the computer codes used for 1976 data could not be identified because the coding system was abandoned soon after 1976 and copies of the code list have been lost. These codes are listed with a question mark in the tables. For fish, the laboratory proceedure was to use a page number from "Pacific Fishes of Canada" (Hart 1973) as a code. Thus the unknown, numbered items are likely fish. They could not be identified with certainty because they referred to either a non-existent page (999) or to a page in the references (700). More than likely these were codes for unidentifiable fish and/or fish remains. They accounted for only three percent of the total number of fish encountered, and occurred in less than four percent of the stomachs. Most of the organisms with unknown alpha-numeric codes were probably insects (Bev Kask, pers. comm.). Each of these codes occurred in less than one percent of the stomachs, and their total numbers represented less than 0.1 percent of the total number of organisms found in all stomachs.

3.6.2 Habitat categories

Stomach contents for 1973 samples were grouped into six habitat categories; marine zooplankton, larval and juvenile fishes, estuarine benthic organisms, larvae of benthos, various eggs, and insects (Appendix Tables 37 and 38). Tables 36 and 37 present grouped data, by month, for chinook and coho in 1973. Tables 38 and 39 present similar data for chinook and coho in 1976. Unfortunately the 1973 data represent a mixture of samples from all gear types and each gear type was used in a different habitat (eg. beach seine on the estuary flat, tow net on the estuary flat and dropoff, purse seine in nearshore waters). This makes it difficult to compare data from 1973 and 1976, since 1976 samples were all collected by purse seine in nearshore waters at the head and along the edge of Cowichan Bay.

To assess comparability of the two data sets, we estimated the percentage of the monthly samples in 1973 that were taken by each gear type as follows. The maximum number of biological samples was supposed to be ten salmon of each species per set. Using this criteria and catch per set data in Appendix Tables 1 to 3a and 9 to 11a, we estimated the sample size, by gear type, for each species and month. Since total estimated sample sizes compared reasonably well with actual sample sizes from summary analyses of stomach contents (Table 40), we assumed that our estimated sample sizes for each gear type were reasonably accurate. As shown in Table 40, samples obtained by beach seine and tow net in 1973 often accounted for close to one-half of all samples.

The 1976 samples of chinook and coho for July through September had higher percentage volumes for larval and juvenile fish than did the 1973 samples for the same period (86-99% vs 50-95%). Estuarine benthic organisms generally accounted for less than five percent by weight of the monthly samples from July onwards. Larvae of benthos and estuarine benthic organisms were more common in 1973 stomach samples before July when between 10 and 50 percent of the samples came from the estuary flat. Marine zooplankton accounted for no more than 4 percent (usually <1%) of the weight of stomach contents during summer months in 1976, but were occasionally over 40 percent of the stomach content weight in 1973. Stomach contents for coho in the two years were more similar than were stomach contents for chinook. Fish (mostly herring) were the dominant diet item for both salmon species each year. In summary, it is likely that most of the differences in stomach contents between 1973 and 1976 were due to samples being collected from different habitats.

3.6.3 Taxonomic categories

Remaining analyses consider 1976 stomach contents grouped into the following categories; polychaetes, copepods, amphipods, euphausiids, decapods (megalops and zoea larvae of crabs), insects (including arachnids), herring and other (mysids, isopods, ostracods, shrimp). Nematodes and parasitic copepods were not included with diet contents, nor were Cenosphaera and Anthocyrtium. The analyses understate the importance of fish due to exclusion of code 430, 455, 700 and 999 fishes (length-weight regressions not available).

The procedure for estimating the weight of stomach contents was checked by comparing the estimate of total content weight for each fish against laboratory measurements of stomach plus content weight (total weight) for each fish. In almost all cases the estimated content weight was less than the total weight, which is to be expected since we did not estimate the empty stomach weight. The few cases where content weight exceeded total weight were due to errors in recording total stomach weight. Estimated content weight for stomachs that were judged to be full were all within a few percent of the total stomach weight.

3.6.3.1 Station comparisons

Summaries of chinook and coho stomach contents are presented for samples taken inside and outside Cowichan Bay in Table 41. The tables contain values of the four diet indices

(numerical frequency, percentage occurrence, weight frequency, and index of relative importance, see Table 4 for definitions), as well as ancilliary information such as average size of predators, numbers and weight of prey per predator, and percentage of empty stomachs. The index of relative importance (Pinkas et al. 1971) is a measure that combines information from the other three indices. It tends to minimize the difference between indices that are weighted towards a few, large diet items, and indices that are weighted towards many small items. Presumably the IRI would be a more appropriate index in situations where small items tended to be digested faster than large items, and hence were more important for growth than their weight percentage would indicate (ie. greater throughput), but less important than their numerical percentage would indicate. However, the IRI is not based on any particular model of fish feeding behavior or growth, and the IRI formulation for combining indices is arbitrary. In this report we use IRI values for comparison of stomach contents amongst time periods, stations, etc.

Herring were clearly the dominant diet item at inside and outside Cowichan Bay stations. (highest IRI values; >90 % by weight for chinook, and > 98 % by weight for coho) (Table 41). Decapod IRI values were second highest except for the small sample (8 fish) of chinook from outside stations for which insects produced the second highest IRI values. Polychaetes were absent from stomachs of fish caught outside Cowichan Bay, and insects were present in stomachs from both locations. Stomach contents, as a percentage of fish weight, ranged from 0.9 percent for the small sample of chinook from outside Cowichan Bay, to 3.2 percent for the coho sample from inside the bay.

Table 42 presents results for samples collected during July and August from head of bay and edge of bay stations. Equal numbers July and August samples were included for edge of bay and head of bay comparisons. Herring again were the dominant diet item, followed by decapod larvae. Other than the absence of polychaetes at edge stations, and higher insect IRI values for head stations, the differences in stomach content between head of bay and edge of bay samples were not large. Stomach contents ranged from 0.9 percent (coho, head of bay) to 2 percent (chinook, head of bay) of body weight.

3.6.3.2 Month comparisons

Stomach samples (1976) from stations inside Cowichan Bay were analysed on a monthly basis and the results are presented in Table 43 (chinook) and Table 44 (coho). Herring produced the highest IRI values in stomachs of both species in all months

except July for chinook when decapod larvae were the dominant item. Decapod larvae generally had the second highest IRI values; insects generally had the third highest IRI values. IRI values for these groups did not change systematically over the four month sampling period. Copepod IRI values were high for chinook in July, otherwise copepods were absent or unimportant diet items. Polychaetes were not present in chinook stomachs in July, but were present in one coho stomach in July. The weight percentage for invertebrates was highest in July (15.3% chinook; 4.2% coho) and lowest in September (1.6% chinook; < 1.0% coho).

The percentage of empty stomachs was lowest for both species in July (5-10%) and ranged from 19-35 percent in remaining months. Stomach content weight as a percentage of fish weight was similar each month for chinook (1.4-1.7%). For coho, stomach content was 6.4 percent of body weight in September, otherwise content weight ranged from 1.1 to 1.3 percent of average body weight. Large herring (40-70 mm) were common in the stomachs of coho sampled in September.

3.6.3.3 Species comparisons

Table 45 presents two comparisons of stomach contents between chinook and coho. The first comparison (left side of table) consisted of pairs of one chinook and one coho that differed in length by no more than ten percent, and that were caught in the same set at stations inside Cowichan Bay. Twenty-six fish of each species from a total of 14 sets fit these criteria (~80 % from July-August head of bay stations). For the second comparison, the requirement of similar size was dropped and chinook and coho were chosen at random with respect to size from the same sets that provided the samples for the first comparison. The same numbers of each species were chosen from each set as were chosen for the first comparison.

In the first comparison, coho and chinook had similar stomach contents. In particular, note the similarity of all index values for decapods and herring. If anything, there was a greater variety of diet items in coho stomachs than in chinook stomachs, which was opposite to previous results, and to the second species comparison where the size restriction was relaxed. Coho in the second comparison were 54 percent longer and almost four times heavier than chinook. As might be expected, herring were by far the dominant item in coho stomachs, whereas for chinook, IRI values were high for herring, insects and decapods. Polychaetes, amphipods and copepods were present in chinook stomachs but not in coho stomachs. These results suggest that changes in size of the two species account for much of the monthly variation in stomach content, and that similar sized

chinook and coho from the same location and time strata have similar diets.

3.7 Previous Estimates of Juvenile Population Size

Table 46 presents estimates of population size for juvenile chinook and coho from the Cowichan and Koksilah Rivers based on several sets of data. The estimates nearest the top of the table were based on CWT recoveries (lower river coho because this group was marked in both years) and inside Cowichan Bay catches from this study; mark releases were reduced to account for CWT loss (Section 3.3). The chinook population estimates from past studies (Armstrong and Argue 1977; Argue, Patterson and Armstrong 1979) were averages of Peterson and Schnabel estimates using catch and mark recovery data collected by the tagging crew in the vicinity of the tagging site; the coho estimate was an average of Peterson estimates from May-June catch and mark recovery data collected by a) the tagging crew while they were beach seining for chinook, and b) from preliminary data from this survey. At the bottom of the table are estimates of juvenile population size calculated by dividing the total escapement of each brood year by the survival of marks to escapement (survival from Table 10).

The latter estimates of juvenile population size represent the populations of juveniles under the assumption that there was no marking mortality. These estimates are higher than all other estimates except the one that was based on May-June recoveries of marked coho, but are less variable between brood years than are estimates based on recoveries of juveniles. We suggest that these results arose because a) significant marking mortality occurred well after juveniles were released thus inflating estimates based on adult escapement over those based on juvenile recoveries, and b) because the previous estimates using juvenile CWT recovery data suffered bias of unknown degree due to uneven distribution of marks amongst the unmarked populations (Sections 3.4.1.3 and 3.5.1.3).

In 1976, dispersal of many marked chinook from the vicinity of the marking site appeared to be delayed by as much as one month, perhaps because their growth was depressed due to the trauma of marking. Delayed dispersal of marks during a period of rapid dispersal by the unmarked population would mean that once marks began behaving in a "normal" manner, they would be amongst a smaller total population.

Marked coho smolts appear to have been randomly distributed amongst the unmarked population and to have dispersed in a "normal" manner once they reached the head of

Cowichan Bay. However, the groups that were released prior to May 22 were less abundant in Cowichan Bay than were the groups released after May 22. This suggests that dispersal from the vicinity of the estuary is a function of time of release. In addition, upper river mark groups were less abundant in Cowichan Bay than lower river mark groups and upper river mark groups had much lower survival to catch and escapement. Table 47 presents separate Peterson estimates of smolt population size using recoveries from upper and lower river releases. These illustrate the different population estimates that arise when different mark groups are used to calculate population size. As expected, estimates of smolt population size based on the upper river release are much greater than estimates based on the lower river release.

Since it is highly unlikely that equal proportions of coho marks were released amongst the smolt populations from different habitats, the total release of marked coho smolts was unlikely representative of the total smolt population. Furthermore, the differences in survival to escapement amongst marked groups could reflect differences in mortality due to marking. If so, the number of tags in each group should be adjusted for mark mortality before calculation of population size.

Both short term (<1 week after marking) and long term mark mortality may affect mark abundance. The low incidence of marks amongst escaping adults (<1-5%) compared to that amongst juveniles in their first ocean year in Cowichan Bay (1-13%), suggests that there was long term mortality associated with marking. On the other hand, CPUE of marked and unmarked chinook and coho followed the same trends in Cowichan Bay from July through October. This suggests that population processes (mortality, migration) operated similarly on marked and unmarked chinook and coho between July and October. For long term mark mortality to have been responsible for the lower incidence of marks on escaping adults, it would have had to affect marked juveniles after October. This seems unlikely. Alternatively, it is possible that marked adults strayed from the Cowichan-Koksilah River system, and/or that unmarked adults from other river systems entered Cowichan Bay at the time tagging and sampling were being conducted to estimate adult population sizes. Both factors would reduce the incidence of marks amongst adults as compared to that amongst juveniles. It is also possible that marked juveniles delayed migration from Cowichan Bay. In this case the measured incidence of marks on juveniles would overestimate the true incidence of marks for the whole population. It is not clear from the available data to what degree these factors were responsible for differences in incidence of marks between juveniles and returning adults.

4.0 DISCUSSION

4.1 Movement of Juveniles Based on CPUE Data

Juvenile chinook appear to be relatively long term residents on the Cowichan estuary. Beach seine, tow net and pole seine sampling from April to August (1973 and 1975) established that juvenile chinook were present on the estuary flat from April through August. In May and June 1975, chinook CPUE by beach seine at estuary flat stations averaged between 21 and 57 fish per set per two week period. This CPUE was similar to that reported by Levings, McAllister and Chang (1985 MS) for wild chinook that were abundant on the Campbell River estuary in 1982, and suggests that the Cowichan estuary was heavily utilized in 1975 by chinook that may have migrated there earlier as fry. The CPUE data also indicate that juvenile chinook move from the estuary flat to deeper water towards the end of June. In contrast to juvenile chinook, coho smolt CPUE by beach seine was generally low on the estuary flat and on intertidal beaches.

On the Nanaimo River, recently emerged chinook fry that migrate downstream are thought to rear for up to 25 days on the estuary (Healey 1980). Previously, Argue, Patterson and Armstrong (1979) had speculated that a large proportion of emergent chinook fry from the Cowichan-Koksilah River system similarly utilized the Cowichan estuary. It was not possible with the available data from this study to determine whether juveniles that migrated downstream as fry, or juveniles that reared in freshwater and migrated downstream in June and July (Lister, Walker and Giles 1971), were dominant in the estuary flat and head of bay catches by beach and purse seine.

Coho fry were present on the estuary flat from April through June, but were not caught afterwards on the estuary flat or by purse seine at the head of bay stations. Coho fry were probably large enough to have been caught by purse seine since the purse seine caught large numbers of small chum fry. These results suggest that migrant coho fry were lost to the population.

Juvenile movement patterns differed amongst the study years. In 1973, there were pronounced peaks in juvenile chinook and coho smolt CPUE during late June and early July at head of bay stations fished by purse seine. CPUEs continued at steady but lower levels until the end of sampling in early September. In 1975, chinook CPUE by purse seine peaked about one week earlier than in 1973 and coho CPUE was highest on the last sampling period at the end of July, two weeks later than the peak CPUE in 1973. In 1976, when purse seine sampling continued past the end

of July, chinook CPUE and coho CPUE did not peak until August at head of Cowichan Bay stations, several weeks before the peak at edge of bay stations; thereafter CPUEs for both species continued at steady and only slightly lower levels. From the above results it appears that juveniles were slower to leave Cowichan Bay in 1976 than in either 1973 or 1975.

Juvenile movement patterns also appeared to differ between the species. Chinook were most abundant at head of bay stations during all months, whereas coho were initially most abundant at edge of bay stations, but by September coho were also concentrated at the head of the bay. Chinook CPUE at stations outside Cowichan Bay was consistently lower than CPUE inside the bay. In contrast, coho CPUE was higher outside the bay in July and August, but was higher inside the bay in September and October. These CPUE patterns are consistent with the hypothesis that coho smolts disperse more rapidly and further than chinook during the first months of ocean residence; then, after an initial dispersal period, a significant proportion of freshwater migrants of both species remain in Cowichan Bay, near the estuary dropoff, until early fall months.

4.2 Movement and Population Size of Juveniles Based on Mark Recoveries

The CWT data allow for a rough evaluation of the degree to which Cowichan chinook and coho juveniles mixed with juveniles from other stocks. High and relatively constant mark percentages in the biweekly purse seine catches inside the bay imply that there was little immigration of non-study area chinook and coho into Cowichan Bay. The Cowichan Bay populations were not completely closed, however, since in 1976 there were recaptures inside the bay of four Puget Sound coho, (2 in July and 2 in September) and one Capilano chinook (in October). Outside Cowichan Bay, the incidence of CWT chinook and coho was similar to that inside the bay. This suggests that a high proportion of first ocean year chinook and coho at caught at stations outside Cowichan Bay (mostly between Maple Bay and the entrance to Saanich Inlet) were from the Cowichan and Koksilah Rivers.

It is tempting to use the adipose clip and CWT sampling data to estimate the size of the rearing population in the bay and at stations outside the bay. However, on the basis of analyses in Section 3.7, this would not be advisable. There was evidence that CWT fish were not representative of the total juvenile population from the Cowichan and Koksilah Rivers, either because of different movement patterns for marked and unmarked fish, or because marks were not representatively applied to segments of the juvenile population that differed in survival and

dispersal from Cowichan Bay. Furthermore, loss of marks from the marked population appeared to be significant but couldn't be measured with the available data. Therefore the assumptions of Armstrong and Argue (1977) and Argue, Patterson and Armstrong (1979) that marks were representative of the unmarked populations, and that marking mortality was negligible, were not supported by the available data, and their estimates of juvenile population size cannot be considered reliable.

4.3 Seasonal Change in Juvenile Size

Mark recoveries by purse seine sampling were the source of data for size analyses. Chinook and coho caught in Cowichan Bay in 1976 increased in fork length at a rate of approximately one millimeter per day from time of release (late June for chinook; mid May for coho) until the end of September. Chinook increased from an average size of 84 mm at time of marking to 169 mm in the last two weeks of September. During the same period coho increased in length from 103 mm to 222 mm. The rate of increase in size for both species did not appear to decrease until October. The average lengths of chinook each month in Cowichan Bay were considerably larger (20-50 mm) than average lengths for wild chinooks sampled from similar marine habitat near the Campbell River estuary (Levings, McAllister and Chang 1985 MS); the average daily increment in length for Cowichan chinook was about double that observed for Campbell River fish. In contrast, Cowichan Bay chinook and coho were considerably smaller each month than chinook and coho caught by purse seine at similar times in Georgia Strait marine rearing areas (Table 48); both groups increased in length at approximately the same rate.

Cowichan chinook caught at the head of the bay tended to be smaller than Cowichan chinook caught along the edges of the bay; Cowichan coho caught inside the bay were smaller than Cowichan coho caught outside the bay. As well, coho that migrated earliest from freshwater to the bay, and therefore had a head start feeding on estuarine and marine organisms, appeared to maintain a size advantage over later migrating smolts for approximately one month. These observations are consistent with a pattern of dispersal that is related to size. In other words as chinook and coho grow, they tend to disperse further and further from the vicinity of the estuary. Such size related movement has been observed for chinook as they moved from the estuarine zone to a transition zone (equivalent to our head of bay stations) on the Fraser, Nanaimo and Campbell Rivers (Healey 1980; Levings 1982; Levings, McAllister and Chang 1985 MS). Size related movement is put forward as partial explanation for the decrease in purse seine CPUE from August through October inside Cowichan Bay.

4.4 Stomach Contents of Juveniles

Chinook and coho from the head and edges of Cowichan Bay fed heavily on herring between July and September (>90% stomach content by weight). Based on the index of relative importance of Pinkas, Oliphant and Iverson (1971), decapod larvae were the second most important item in the diet of these species inside Cowichan Bay. However, after July, decapods accounted for less than one percent of the estimated weight of the stomach contents of either species. In a diet analysis of fish caught from the same sets, stomach contents of chinook and coho of similar size differed little, whereas stomach contents of chinook and coho that differed in size differed greatly. Larger fish had greater proportions of herring in their diets.

Diet items that originated from the epibenthos of the estuary, such as polychaetes and many of the amphipods, were of only minor importance in the diet of chinook and coho caught from July to October in nearshore waters of Cowichan Bay, but were important items in the diet of chinook and coho caught prior to July on the estuary flat. Larval and juvenile fish, and marine zooplankton, were the dominant diet items in chinook and coho caught between July and October in nearshore waters. Our analyses are consistent with observations by Healey (1980) and Levy, Northcote and Barr (1982) which showed that chinook and coho diet shifts from estuarine organisms to marine fish and plankton as juveniles increase in size and move to habitats seaward of the estuary.

4.5 Summary

Juvenile chinook and coho fry were captured on the Cowichan estuary between early April and late June. At this time estuarine benthic organisms were important diet items. Chinook then appeared to move into deeper water seaward of the estuary flat; coho fry were not caught after June. A large but unknown proportion of chinook juveniles and coho smolts remained resident in Cowichan Bay, close to the estuary, for the duration of the summer. During this time the diet of both species was dominated by herring.

Marked Cowichan coho increased in length at the same rate inside and outside Cowichan Bay (~1 mm per day). Cowichan chinook captured in Cowichan Bay increased in length at the same rate as coho. Coho and chinook caught outside Cowichan Bay were consistently larger than those caught inside the bay. It was hypothesized that progressive seaward movement of juveniles of

these species was a function of increases in size.

Juvenile coho residence in Cowichan Bay was also related to migration timing from freshwater, such that early migrants spent the least time in Cowichan Bay. These coho appeared to achieved a growth "advantage" by earlier occupation of productive estuarine and nearshore waters. We hypothesize that seaward dispersal of juveniles from Cowichan Bay is greatest for the early migrants from freshwater; and that later migrants tend to stay near the estuary for a longer period, presumably to feed on abundant prey such as juvenile herring.

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6.0 LITERATURE CITED

Anon. 1972-1976. Surface water data, British Columbia. Inland Waters Branch, Dept. Env. Can., Water Survey Can. 316 pp.

Anon. 1980. The Cowichan/Koksilah Rivers their estuary and fisheries - Status of current information from 1974 to 1978. Cowichan Estuary Task Report, Appendix 8. Habitat Protection Div., Can. Dep. Env. 45 pp.

Anon. 1985. Salmonid catch sampling and mark recovery program. An executive review. Report prepared under Dept. Supply Serv. by J.E. Sager and Assoc. for the Dept. Fish. Oceans. 13 p.

Argue, A.W. 1976.. Preliminary information from the 1973 and 1974 Canadian chinook and coho catch sampling and mark recovery programs. Can. Dep. Env., Fish. Serv., Pac. Region, Tech. Rept. Ser. PAC/T-76-9. 32 pp.

Argue, A.W., R. Hilborn, R.M. Peterman, M. Staley, and C.J. Walters. 1983. Strait of Georgia chinook and coho fishery. Can. Bull. Fish. Aquat. Sci. 211. 91 p.

Argue, A.W., L.M. Patterson, and R.W. Armstrong. 1979. Trapping and coded-wire tagging of wild coho, chinook and steelhead from the Cowichan-Koksilah River system, 1976. Can. Fish. Mar. Serv. Tech. Rep. 850: 117 pp.

Armstrong, R.W., and A.W. Argue. 1977. Trapping and coded-wire tagging of wild coho and chinook juveniles from the Cowichan River system, 1975. Can. Fish. Mar. Serv. Tech. Rep. Ser. PAC/T-77-14: 58 pp.

Bell, L.M., and R.J. Kallman. 1976. The Cowichan-Chemainus River estuaries, status of environmental knowledge to 1975. Can. Fish. Mar. Serv., Pac. Env. Instit. Spec. Estuary Ser. No. 4, 328 pp.

Blankenship, L. 1981. Coded-wire tag loss study. Wash. Dep. Fish. Tech. Rep. No. 65, 26 pp.

Fulton, J. 1968. A laboratory manual for the identification of British Columbia marine zooplankton. Tech. Rept. Fish Res. Board Can. 55, 141 pp.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Can. Bull. 180: 740 pp.

Healey, M.C. 1980. Utilization of the Nanaimo River estuary by

juvenile chinook salmon Oncorhynchus tshawytscha. U.S. Nat. Mar. Fish. Serv. Fish. Bull. 77: 653-668.

Healey, M.C. 1982. Juvenile Pacific salmon in estuaries: the life support system. pp 315-341. in V.S. Kennedy (ed.) Estuarine comparisons. Academic Press, New York.

Jefferts, K.B., P.K. Bergman, and H.F. Fiscus. 1963. A coded wire identification system for micro-organisms. Nature 198 (4879): 460-462.

Koo, T.S.Y. 1962. Age designation in salmon. pp 37-48. In: T.S.Y Koo (ed). Studies of Alaska red salmon. Univ. Wash. Press.

Levings, C.D. 1982. Short term use of a low tide refuge in a sandflat by juvenile chinook, (Oncorhynchus tshawytscha), Fraser River estuary. Can. Tech. Rept. Fish. Aquat. Sci. No. 1111, 33 pp.

Levings, C.D., C.D. McAllister, and B.D. Chang. 1985 MS. Use of the Campbell River estuary, British Columbia, by wild and hatchery-reared juvenile chinook salmon (Oncorhynchus tshawytscha). Submitted to the Can. J. Fish. Aquat. Sci.

Levy, D.A., and T.G. Northcote. 1982. Juvenile salmon residency in a marsh area of the Fraser River estuary. Can. J. Fish. Aquat. Sci. 39(2): 270-276.

Levy, D.A., T.G. Northcote, and R.M. Barr. 1982. Effects of estuarine log storage on juvenile salmon. Westwater Res. Center Tech. Rep. 26: 101 pp.

Lister, D.B., L.M. Thorson, and I. Wallace. 1981. Chinook and coho salmon escapements and coded-wire tag returns to the Cowichan-Koksilah River system 1976-1979. Can. MS Rep Fish. Aquat. Sci. No. 1608, 78 pp.

Lister, D.B., C.E. Walker, and M.A. Giles. 1971. Cowichan River chinook escapements and juvenile production, 1965-1967. Can. Dep. Fish. For. Fish. Serv., Pacific Region, Tech. Rep. 1971-3. 48pp.

Marshall, D.E., R.F. Brown, V.D. Chahley, and D.G. Demontier. 1976. Preliminary catalogue of salmon streams and spawning escapements of statistical areas 17 and 18 (Nanaimo - Ladysmith - Duncan). Can. Fish. Mar. Serv. Data. Rep. Ser. PAC/D-76-6: 90p.

Palermo, V. 1985 MS. Awareness factor variability in the Strait of Georgia sport fishery. Submitted to the Can. J. Fish.

Aquat. Sci. 72 p.

Parker, R.R. 1963. Effects of formalin on lengths and weights of fishes. J. Fish. Res. Board Canada 20: 1441-1455.

Pinkas, L., M.S. Oliphant, and I.L. Iverson. 1971. Food habits of albacore, bluefin tuna, and bonito in California waters. Calif. Dep. Fish. Game Fish Bull. 152: 105 pp.

Reimers, P.E. 1973. The length of residence of fall chinook salmon in Sixes River, Oregon. Res. Rept. Oregon. Fish Comm. 4: 1-43.

Smoker, W.A. 1953. Stream flow and silver salmon production in western Washington. Wash. State Dept. Fish., Fish, Res. Papers, 1(1): 5-12.

Sokal, R.R., and F.J. Rohlf. 1969. Biometry. The principles and practices of statistics in biological research. W.H. Freeman and Company. 776 p.

Sparrow, R.A.H. 1968. The freshwater and early life ecology of chinook salmon from the Cowichan River, with particular emphasis on the differences in life history between early and late migrant fish. Fish. Res. Board Can., Nanaimo Bio. Stn. Unpub. MS 17pp.

TABLES

Table 1. Timing of sampling by each gear type. Each cross represents at least one set per two week time period.

Year	Sampling Gear	March		April		May		June		July		August		September		October	
		1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31
1973	Beach Seine		X	X	X	X	X	X	X	X	X	X	X				
	Tow Net			X	X	X	X	X	X	X	X	X					
	Pole Seine				X	X	X	X	X	X	X						
	Purse Seine	X	X	X	X	X	X	X	X	X	X	X	X	X			
1975	Beach Seine				X	X	X	X	X	X	X						
	Purse Seine			X		X	X	X	X	X	X						
1976	Purse Seine						X	X	X	X	X	X	X	X	X	X	X

Table 2. Purse seine and beach seine station groupings.*

Year	Grouped Stations		
	Head of Bay	Edge of Bay	Middle of Bay
	PURSE SEINE		
1973	1 - 4		5
1975	3 - 6	1, 2, 7, 8	
1976	3, (3.5), 4, (4.5), 5, 6	1, 2, (2.5), (6.5), 7, 8	9, 10
	BEACH SEINE		
1973	2 - 7	1	
1975	3 - 7	1, 2, (8-19)	

* Data from bracketed station numbers were excluded from relative abundance analyses.

Table 3. Number of releases of coded-wire tagged and adipose clipped coho and chinook juveniles, by release site, release period and tag code, 1975 and 1976.*

Tagging/ Brood Year	Species and Life History Stage	Tagging		Number of Mark Releases		CWT Code	Time/Location of Release +	Fork Length (mm)		
		Location	Dates	Mark	Ad + CWT**			Mean	SD	N
1975/1973	Coho Smolt	Rotary Park	16 Apr - 23 May	10,540	10,208	10/2/5	EARLY/LOWER	98	11.8	184
			16 Apr - 1 May	757	733	8/2/5	EARLY/LOWER			
			24 May - 12 Jun	7,631	7,391	9/2/5	LATE/LOWER	98	9.4	119
			Total	18,928	18,332					
		Pastuch Creek	11 Apr - 6 Jun	4,110	3,981	6/2/5	Total/Upper	83	13.6	360
		Cowichan Side Ch	11 Apr - 18 Apr	3,097	2,999	14/2/5	Early/Middle	88	10.2	50
			1975/1973 Total	26,135	25,312					
1975/1974	Chinook Fingerling	Cowichan Estuary	23 Jun - 2 Jul	18,332	17,250	7/2/5	TOTAL/ESTUARY	76	10.8	100
1976/1974	Coho Smolt	Rotary Park	23 Apr - 19 May	4,816	4,665	5/2/7	EARLY/LOWER	92	12.5	400
			20 May - 15 Jun	5,609	5,435	6/2/7	LATE/LOWER	94	10.7	400
			Total	10,425	10,100					
		Pastuch Creek	30 Apr - 7 Jun	3,439	3,332	9/2/7	Total/Upper	89	10.3	500
		Cowichan Side Ch	14 Apr	3,909	3,787	10/2/7	Early/Middle	127	28.9	167
			Sub Total	17,773	17,219					
	Coho Smolt	Mesachie Creek	23 Apr - 30 Apr	4,153	4,023	7/2/7	EARLY/UPPER	82	11.7	100
			30 Apr - 18 May	15,619	15,128	8/2/7	EARLY/UPPER	104	16.4	300
			18 May - 24 May	10,465	10,135	13/2/7	EARLY/UPPER	109	10.5	200
			24 May - 15 Jun	12,666	12,269	11/2/7	LATE/UPPER	110	10.5	100
			Total	42,903	41,555					
		Kelvin Creek	24 Apr - 19 May	6,829	6,614	3/2/7	EARLY/LOWER	106	23.2	497
			20 May - 15 Jun	6,978	6,764	4/2/7	LATE/LOWER	92	11.5	350
			Total	13,807	13,378					
			1976/1974 Total	74,483	72,152					
1975/1974	Chinook Fingerling	Cowichan Estuary	18 Jun - 14 Jul	17,722	16,673	1/2/7	TOTAL/ESTUARY	84	19.0	494

* Source: Armstrong and Argue (1977); Argue, Patterson and Armstrong (1979)

** Mark releases adjusted for tag loss within approximately 1 week of tagging. 1975 Mark releases reduced by 1976 average preliberation tag loss percentages (3.15% for coho; 5.90% for chinook) in order to estimate the number of Ad+CWTs releases in 1975.

\+ Capitals indicate CWT groups that were used in relative abundance analyses.

Table 4. Formulae used to describe stomach contents of chinook and coho salmon.

$$N = \text{Numerical Percentage} = \left[\frac{\text{Total number of a particular Prey item in all stomachs}}{\text{Total number of all prey in all stomachs}}\right] \times 100$$

$$F = \text{Frequency of Occurence} = \left[\frac{\text{Number of stomachs containing at least one particular prey}}{\text{Total number of stomachs examined for food}}\right] \times 100$$

$$W = \text{Weight Percentage} = \left[\frac{\text{Total wet weight of a particular prey item in all stomachs}}{\text{Total wet weight of all prey in all stomachs}}\right] \times 100$$

$$IRI = \text{Index of Relative Importance} = (N + W) \times F$$

Table 5. Regression coefficients for length (mm) to weight (mg) conversions that were used to calculate wet weight of different prey items in salmon stomachs.

Diet Item	Intercept	Slope
Polychaetes	0.108	1.513
Copepods	0.057	2.540
Mysids	0.030	2.550
Isopods	0.015	3.830
Amphipods:		
Anisogammarus	0.036	2.560
Cyphocaris	0.105	2.420
Parathemisto	0.082	2.644
Corophium	0.028	2.907
Euphausiids	0.057	2.208
Decapods:		
Shrimp juveniles	0.162	2.150
Zoea larvae	0.034	2.781
Insects:		
Chironomid larva	0.046	1.529
All other	0.222	1.047
Herring:		
<35mm length	0.004	2.980
>35mm length	0.002	3.330

* log(weight(mg))=log(a)+b*log(length(mm). Source: Fulton (1968), Bev Cask and Tom Brown, personal communication.

Table 6. Total catch of chinook and coho salmon by year and sampling gear, inside Cowichan Bay.*

Species	Age Group**	1973					1975			1976	
		Pole Seine	Tow Net	Beach Seine	Purse Seine+	Total 1973	Beach Seine	Purse Seine	Total 1975	Purse Seine	Grand Total
Chinook	age 0.	2	346	182	4,038	4,568	695	2,608	3,303	4,034	11,905
	age 0.1	-	-	-	-	-	-	37	37	65	102
	Total	2	346	182	4,038	4,568	695	2,645	3,340	4,099	12,007
Coho	age 0.	24	68	202	-	294	15	-	15	-	309
	age 1.	-	14	48	2,789	2,851	181	2,104	2,285	2,120	7,256
	age 1.1	-	-	-	-	-	-	62	62	32	94
	Total	24	82	250	2,789	3,145	196	2,166	2,362	2,152	7,659

* Source: Appendix Tables 1 to 5, 7, 9 to 12, 14.
** Age estimated from size at time of capture. Age 0. (fry, fingerling) and 1. (smolt) fish are referred to as juveniles in this report. Age 0.1 and 1.1 fish have spent one winter in the ocean (second ocean year fish) and are not included in analyses in this report.
+ Chinook and coho assumed to have been age 0. and 1., respectively.

ble 7. Total catch of species other than chinook and coho salmon caught inside Cowichan Bay during the 1973, 1975 and 1976 sampling seasons as recorded on field record sheets.*

Species	1973+				1975		1976	
	Pole Net	Tow Net	Beach Seine	Purse Seine	Beach Seine	Purse Seine	Purse Seine	Total
ver Lamprey (Lampetra ayresi)							2	2
rring (Clupea harengus)		1,937	3,724	57,613	470	722,006+	256,100+	1,041,850+
rthern Anchovy (Engraulis mordax)		7					7	14
identified Salmonids		99	28					127
ckeye Salmon (Oncorhynchus nerka)		1				1		2
nk Salmon (Oncorhynchus gorbuscha)		4	1					5
um Salmon (Oncorhynchus keta)	9	450	795	567	5,260	35,347	4,319	46,767
tthroat Trout (Salmo clarki)			1		1	1	1	4
eelhead Trout (Salmo gairdneri)						3	1	4
rf Smelt (Hypomesus pretiosus)		2	6		1	13	57	79
identified Smelt			2					2
ainfin Midshipman (Porichthys notatus)					1			1
identified Tubesnouts			4					4
reespine Stickleback (Gasterosteus aculeatus)	49	126	132	26,944	75	339	33,492	61,157
y Pipefish (Syngnathus griseolineatus)		1	1		21		3	26
identified Perch			29		40		5,050	5,119
iner Perch (Cymatogaster aggregata)		55	4,441	1,470	1,026		10	7,002
riped Seaperch (Embiotoca lateralis)					2			2
le Perch (Rhacochilus vacca)					2		3	5
identified Gunnel		1	7		67			75
ake Prickleback (Lumpenus sagitta)					35		4	39
escent Gunnel (Pholis laeta)					2			2
ddleback Gunnel (Pholis ornata)							1	1
cific Sand Lance (Ammodytes hexapterus)							1,207	1,207
ack Rockfish (Sebastes melanops)						1		1
identified Greenling					11			11
agcod (Ophiodon elongatus)							1	1
identified Cottids	18	1	1,257		772	1	14	2,063
arpnose Sculpin (Clinocottus acuticeps)			3					3
cific Staghorn Sculpin (Leptocottus armatus)	3	5	412	1		22		443
depool Sculpin (Oligocottus maculosus)			2					2
ickly sculpin (Cottus asper)	14		137					
identified Flatfish		12	87		62	3	3	167
arry Flounder (Platichthys stellatus)			38			3	14	55
) Sole (Pleuronichthys coenosus)					1			1
otal:	93	2,701	11,107	86,615	7,849	757,740+	300,289+	1,166,394

n addition to the species recorded in this table for 1973, Barrett (1977 MS) reported catches of longfin smelt Spirinchus thaleichthys), pile perch (Rhacochilus vacca) saddle back gunnel (Pholis ornata), Pacific sand lance Ammodytes hexapterus), black rockfish (Sebastes melanops), whitespotted greenling (Hexagrammus stelleri), addleback sculpin (Oligocottus rimensis), and unidentified liparids. These additional fish were presumably caught y purse seine. 1973 purse seine data was not available for this analysis.
973 catches of herring, chum salmon, stickleback, shiner perch, staghorn sculpin and prickly sculpin taken from summary ables provided by D. Barrett (pers. comm.).

Table 8. Mark (adipose clip) and CWT recoveries from chinook and coho that were examined for marks inside and outside Cowichan Bay in 1975 and 1976.

	1975					1976			
		Purse Seine				Purse Seine			
	Beach Seine	Inside	Outside	Total	Total 1975	Inside	Outside	Total 1976	Grand Total
					CHINOOK Age 0.				
Number Examined for Marks	695	2,608	813	3,421	4,116	4,034	367	4,401	8,517
Marks Returned (Caught)*	-	14 (18)	6 (11)	20 (29)	20 (29)	294 (295)	8 (8)	302 (303)	322 (332)
CWTs**	-	11	4	15	15	276	6	282	297
Percent Marked	-	0.7%	1.4%	0.8%	0.7%	7.3%	2.2%	6.9%	3.9%
Percent Marks with CWTs	-	78.6%	66.7%	75.0%	75.0%	93.9%	75.0%	93.4%	92.2%
					COHO Age 1.				
Number Examined for Marks	181	2,104	749	2,853	3,034	2,120	1,001	3,121	6,155
Marks Returned (Caught)*	7 (7)	64 (84)	29 (34)	93 (118)	100 (125)	183 (189)	83 (84)	266 (273)	366 (398)
CWTs**	4	55	24	79	83	153	77	230	313
Percent Marked	3.9%	4.0%	4.5%	4.1%	4.1%	8.9%	8.4%	8.7%	6.5%
Percent Marks with CWTs	57.1%	85.9%	82.8%	84.9%	83.0%	83.6%	92.8%	86.5%	85.5%

* Marks caught differ from marks returned to the laboratory because not all marks that were caught were returned to the laboratory for examination for coded-wire tags (Section 3.2). Marks returned, marks caught and CWTs exclude marks from 1973 brood chinook recaptured in 1975, and from 1974 brood chinook recaptured in 1976; also excluded are marks for which field recapture records were not available.

** Excludes CWTs that were lost in the laboratory, CWTs for which field records were not available, and CWTs from 1973 brood chinook recaptured in 1975, and from 1974 brood chinook recaptured in 1976.

Table 9. Recaptures of non-study area chinook and coho that contained coded-wire tags, 1975 and 1976.

Species	Tagging Location	Recapture Information				Additional Release Information	Assumed Brood Year*
		Station	Date	Length (mm)	Weight (gm)		
Chinook	Capilano Hatchery	6	27 May 1975	300	NA	released 11 Jun 1974	1973
Chinook	Portage Bay WA	6	10 Jun 1975	355	NA	NA	1973
Chinook	Deschutes WA	5	5 Jul 1976	234	153.6	1974 brood year	1974
Chinook	Capilano Hatchery	2.5	20 Aug 1976	133	29.2	released 11 Jun 1973?	1975
Chinook	Unknown CWT code	3	27 Sep 1976	180	73.5	NA	1975
Chinook	Capilano Hatchery	3	1 Oct 1976	171	60.9	released 17 Jun 1976	1975
Chinook	Unknown CWT code	C5	28 Oct 1976	198	102.0	NA	1975
Coho	Skykomish WA	7	8 Jul 1975	163	60.8	released 3 May 1975	1973
Coho	Skagit WA	5	21 Jul 1975	205	108.2	NA	1973
Coho	Capilano Hatchery	B10	23 Jul 1975	208	115.2	released 11 Jun 1974	1973
Coho	Samish WA	B22	21 Jul 1976	232	170.6	1974 brood year	1974
Coho	Skagit WA	B10	17 Aug 1976	197	99.8	released May 1976	1974
Coho	Skagit WA	6	1 Sep 1976	233	167.4	released May 1976	1974
Coho	Skagit WA	4	2 Sep 1976	215	131.0	released May 1976	1974
Coho	Unknown CWT code	C5	30 Sep 1976	279	250.2	NA	1974

* CWT codes were not available so brood year had to be assumed on the basis of additional release information and size at time of recovery.

Table 10. Estimated catch, escapement and survival for Ad-CWT groups of Cowichan and Koksilah River coho and chinook marked in 1975 and 1976.*

Species	Release/ Brood Year	Time of CWT Release	Location of Release	CWT Codes	Number Released		Estimated Ad-CWT Returns			Percent Survival of Ad-CWT
					Marks	Ad-CWT**	Catch	Escape.	Total	
Coho	1975/1973	Early	Lower River	10/2/5 8/2/5	11,297	9,817	1,792	127	1,919	19.6%
		Late	Lower River	9/2/5	7,631	6,631	1,429	127	1,556	23.5%
		Total			18,928	16,448	3,221	254	3,475	21.1%
Coho	1976/1974	Early	Lower River	5/2/7 3/2/7	11,645	10,562	985	475	1,460	13.8%
		Late	Lower River	6/2/7 4/2/7	12,587	11,416	1,059	462	1,521	13.3%
		Total			24,232	21,978	2,044	937	2,981	13.6%
		Early	Upper River	7/2/7 8/2/7 13/2/7	30,237	27,425	2,392	869	3,261	11.9%
		Late	Upper River	11/2/5	12,666	11,488	685	272	957	8.3%
		Total			42,903	38,913	3,077	1,141	4,218	10.8%
Chinook	1975/1974	Total	Estuary	7/2/5	18,332	16,554	965	49	1,014	6.1%
Chinook	1976/1975	Total	Estuary	1/2/7	17,722	16,003	902	64	966	6.0%

* Estimated commercial and sport catch from DFO preliminary Mark Recovery Program data (Margaret Birch, personal communication). Estimated escapement from Lister, Thorson and Wallace (1981).

** Marks have been adjusted for CWT loss using estimates from Lister, Thorson and Wallace (1981)- 9.7% for both chinook brood years, 13.1% for 1973 brood year coho, and 9.3% for 1974 brood year coho.

Table 11. Beach seine catch per set for chinook juveniles, 1973 and 1975.

Date	Head of Bay				Edge of Bay*				Edge of Bay 1975 Stations 8-19	
	1973		1975		1973		1975			
	Catch/ Effort	Sets	Catch/ Effort	Sets	Catch/ Effort	Sets	Catch/ Effort	Sets	Catch/ Effort	Sets
Mar 15-31	-	6			-	1				
Apr 1-15	0.5	6			-	1				
16-31	-	6	4.0	2	-	1	-	2		
May 1-15	-	5	33.0	4	-	1	-	2		
16-31	3.2	11	20.7	3	-	2	0.3	3		
Jun 1-15	7.8	6	57.4	5	13.0	1	-	6	6.07	15
16-30	1.3	6	14.7	3	6.0	1	12.5	2	13.3	3
Jul 1-15	0.8	6	-	1	-	1	0.5	2	0.7	3
16-31	0.2	6	0.7	3	1.0	1	-	2	-	3
Aug 1-15	-	5			-	1				
16-31	-	6			-	1				
	1.4	69	25.5	21	1.7	12	1.4	19	5.5	24

* 1973, Station 1; 1975, Stations 1 and 2.

Table 12. Purse seine catch per set for chinook, 1973.

Date	Head of Bay		Middle of Bay	
	Catch/ Effort	Sets	Catch/ Effort	Sets
Mar 1-15	-	4	-	
16-31	0.8	4	-	1
Apr 1-15	0.3	4	-	1
16-30	0.8	4	0.3	1
May 1-15	-	4	-	1
16-31	3.3	8	-	2
Jun 1-15	104.3	4	2.5	1
16-30	235.8	4	12.0	1
Jul 1-15	355.5	4	1.0	1
16-31	39.3	4	-	1
Aug 1-15	57.5	4	-	1
16-31	73.8	4	-	1
Sep 1-15	130.5	4	-	1
Total	71.8	56	1.5	13

Table 13. Purse seine catch per set for chinook, 1975 and 1976.*

	Head of Bay				Edge of Bay				Middle of Bay		Outside Bay			
	1975		1976		1975		1976		1976		1975		1976	
Date	Catch/ Effort	Sets	Catch/ Effort	Sets	Catch/ Effort	Sets	Catch/ Effort	Sets	Catch/ Effort	Sets	Catch/ Effort	Sets	Catch/ Effort	Sets
Apr 16-30	2.3	8			0.5	8								
May 1-15	-	8			-	8								
16-31	0.4	8	2.8	4	1.3	8	1.5	4	-	2				
Jun 1-15	6.4	8	0.7	6	7.8	8	0.8	4	-	2	5.8	5	1.3	6
16-30	125.1	8	4.3	7	40.1	8	1.8	4	0.5	2	9.6	12		
Jul 1-15	27.5	8	22.1	17	18.1	8	5.0	4	-	2	15.1	15	2.5	4
16-31	82.1	8	33.1	11	14.5	8	7.5	6	-	2	34.1	13	3.4	11
Aug 1-15			42.5	4			8.6	4	-	2			2.5	2
16-31			29.1	9			39.6	11	-	4			18.9	10
Sep 1-15			33.6	13			18.2	5	-	2			2.0	6
16-30			17.4	15			12.5	4	-	2			4.4	19
Oct 1-15			22.1	15			11.3	4	-	2			1.4	14
16-31			8.3	18			2.5	4	0.5	2			0.5	6
Total	34.8	56	20.1	119	11.8	56	14.0	54	0.1	24	18.1	45	4.7	78

* Stations 2.5, 3.5, 4.5, and 6.5 excluded in 1976.

Table 14. Estimated chinook escapement, and peak daily daily discharge (cfs) between October and December in the escapement year.*

Escapement Year	Cowichan River	Koksilah River	Total	Peak Daily Discharge
1971	7,500	400	7,900	4,100
1972	8,500	275	8,775	3,050
1973	8,000	400	8,400	5,050
1974	3,500	600	4,100	3,720
1975	6,000	500	6,500	8,350

* Source: escapement from Marshall et al. (1976); discharge from Anon (1972-1976).

Table 15. Percentage of marked chinook in the catch at each purse seine station inside Cowichan Bay, 1975 and 1976.*

	1975		1976	
Station	Percent Marked	Total Catch	Percent Marked	Total Catch
1	-	13	3.08	65
2	-	61	4.83	373
2.5			4.46	359
3	1.23	243	7.35	1062
3.5			4.00	100
4	-	535	5.86	239
4.5			66.67	6
5+	0.31	643	9.95	221
6+	1.51	529	9.97	873
6.5+			7.45	416
7	1.14	352	7.59	237
8	0.43	232	1.23	81
9			-	-
10			-	2
Total	0.69	2,608	7.31	4,034

* Source: Appendix Tables 5-8.
+ Station 6 is at the marking site and stations 5 and 6.5 are nearby.

Table 16. Percentage of adipose clipped chinook in the purse seine catch at grouped stations, 1975 and 1976.

Date	Head of Bay				Edge of Bay				Outside Bay			
	1975		1976		1975		1976		1975		1976	
	Percent Marked	Total Catch	Percent Marked	Total Catch	Percent Marked	Total Catch	Percent Marked	Total Catch	Percent Marked	Total Catch	Percent Marked	Total Catch
Apr 16-30	-	18			-	4						
May 1-15	-	-			-	-						
15-31	-	3	-	11	-	10	-	6				
Jun 1-15	-	51	-	4	-	62	-	3	-	29	-	8
16-30	-	1001	-	39	-	321	-	7	-	115		
Jul 1-15	1.36	220	11.05	380	-	145	8.30	277	-	227	-	10
16-31	1.52	657	8.79	364	4.31	116	0.94	106	2.49	442	-	37
Aug 1-15			9.41	170			7.92	101			-	5
16-31			12.98	262			4.78	795			1.59	189
Sep 1-15			6.28	494			6.50	123			-	12
16-30			6.62	272			5.26	57			3.57	84
Oct 1-15			6.33	332			6.67	45			5.26	19
16-31			8.67	173			18.18	11			33.33	3
Total	0.67	1950	8.36	2501	0.76	658	5.62	1531	1.35	813	2.18	367

Table 17. Percentage of chinook with CWTs in chinook catches by purse seine in July 1975 and in July 1976 at the same head, edge and all outside Cowichan Bay stations.*

	Grouped Stations			
Years	Head	Edge	Outside Total	Totals
1975	1.4%	1.2%	1.1%	1.2%
1976	8.7%	0.3%	-	5.7%
Total	4.7%	0.6%	1.0%	3.0%

Source: Appendix Table 25.

Table 18. Percentage of chimook with CWTs in chinook catches by purse seine in 1976 at all head, edge and outside Cowichan Bay stations.*

	Grouped Stations			
Months	Head	Edge	Outside Total	Totals
Jul-Aug	9.9%	5.1%	0.8%	6.8%
Sep-Oct	6.2%	6.0%	2.6%	5.9%
Total	8.0%	5.2%	1.4%	6.5%

* Source: Appendix Table 26.

Table 19. Beach Seine catch per set for coho fry, 1973 and 1975.*

Date	Head of Bay 1973 Catch/ Effort	Head of Bay 1973 Sets	Head of Bay 1975 Catch/ Effort	Head of Bay 1975 Sets	Edge of Bay 1973 Catch/ Effort	Edge of Bay 1973 Sets	Edge of Bay 1975 Catch/ Effort	Edge of Bay 1975 Sets	Edge of Bay 1975 Stations 8-19 Catch/ Effort	Edge of Bay 1975 Stations 8-19 Sets
Mar 15-31	-	6			-	1				
Apr 1-15	2.2	6			-	1				
16-30	-	6	-	2	-	1	-	2		
May 1-15	1.0	5	-	4	-	1	-	2		
16-31	7.5	11	-	3	1.5	2	-	3		
Jun 1-15	6.3	6	0.2	5	1.0	1	-	6	0.4	15
16-30	6.3	6	-	3	2.0	1	-	2	-	3
Jul 1-15	-	6	3.0	1	-	1	-	2	1.7	3
16-31	-	6	-	3	-	1	-	2	-	3
Aug 1-15	-	5			-	1				
16-31	-	6			-	1				
Total:	2.6	69	0.2	21	0.5	12	0.0	19	0.5	24

* 1973 Station 1; 1975 Stations 1 and 2.

Table 20. Beach seine catch per set for coho smolts, 1973 and 1975.*

Date	Head of Bay 1973 Catch/ Effort	Head of Bay 1973 Sets	Head of Bay 1975 Catch/ Effort	Head of Bay 1975 Sets	Edge of Bay 1973 Catch/ Effort	Edge of Bay 1973 Sets	Edge of Bay 1975 Catch/ Effort	Edge of Bay 1975 Sets	Edge of Bay 1975 Stations 8-19 Catch/ Effort	Edge of Bay 1975 Stations 8-19 Sets
Mar 15-31	-	6			-	1				
Apr 1-15	-	6			-	1				
16-30	-	6	0.0	2	-	1	0.5	2		
May 1-15	0.2	5	5.5	4	-	1	0.5	2		
16-31	0.7	11	14.0	3	2.5	2	10.3	3		
Jun 1-15	0.5	6	0.6	5	1.0	1	7.0	6	2.3	15
16-30	5.3	6	0.7	3	3.0	1	1.0	2	-	3
Jul 1-15	-	6	-	1	-	1	-	2	0.3	3
16-31	-	6	-	3	-	1	-	2	-	3
Aug 1-15	-	5			-	1				
16-31	-	6			-	1				
Total:	0.6	69	3.3	21	0.8	12	4.1	19	1.5	24

* 1973, Station 1; 1975, Stations 1 and 2.

Table 21. Purse seine catch per set for coho, 1973.

Date	Head of Bay		Middle of Bay	
	Catch/ Effort	Sets	Catch/ Effort	Sets
Mar 1-15	-	4	-	
16-31	-	4	-	1
Apr 1-15	-	4	-	1
16-30	-	4	-	1
May 1-15	-	4	-	1
16-31	17.9	8	30.5	2
Jun 1-15	25.3	4	2.0	1
16-30	325.5	4	2.0	1
Jul 1-15	117.3	4	6.0	1
16-31	104.0	4	-	1
Aug 1-15	18.8	4	2.0	1
16-31	17.5	4	-	1
Sep 1-15	35.0	4	-	1
Total	48.5	56	5.6	13

Table 22. Purse seine catch per set for coho, 1975 and 1976.*

Date	Head of Bay				Edge of Bay				Middle of Bay		Outside Bay			
	1975		1976		1975		1976		1976		1975		1976	
	Catch/ Effort	Sets	Catch/ Effort	Sets	Catch/ Effort	Sets	Catch/ Effort	Sets	Catch/ Effort	Sets	Catch/ Effort	Sets	Catch/ Effort	Sets
Apr 16-30	-	8			-	8								
May 1-15	19.0	8	1.8	4	-	8	5.3	4	1.5	2	32.6	5	4.0	6
16-31	4.0	8	7.7	6	5.3	8	3.8	4	5.5	2	20.8	12		
Jun 1-15	13.6	8	4.1	7	12.0	8	0.5	4	0.5	2	14.7	15	17.5	4
16-30	30.4	8	8.3	17	18.6	8	4.0	4	0.5	2	9.1	13	21.1	11
Jul 1-15	45.6	8	24.0	11	33.5	8	7.8	6	-	2			19.0	2
16-31	77.6	8	8.0	4	3.4		7.5	4	-	4			22.9	10
Aug 1-15			13.8	9			12.5	11	-	2			13.3	6
16-31			20.7	13			10.6	5	-	2			12.1	19
Sep 1-15			10.0	15			3.8	4	-	2			6.6	14
16-30			11.2	15			1.5	4	-	2			1.0	6
Oct 1-15			3.3	18			0.3	4						
16-31														
Total	27.2	56	10.8	119	10.4	56	6.4	54	0.7	24	16.6	45	12.8	78

* Stations 2.5, 3.5, 4.5 and 6.5 excluded in 1976.

Table 23. Estimated coho escapement, and minimum monthly average daily discharge (cfs) between June and October in the year following the escapement year.*

Escapement Year	Cowichan River	Koksilah River	Total	Average Daily Discharge
1971	75,000	3,500	78,500	270
1972	9,000	1,800	10,800	258
1973	30,000	5,000	35,000	284
1974	75,000	10,000	85,000	311
1975	40,000	10,000	50,000	365

* Source: escapement from Marshall et al. (1976); discharge from Anon (1972-1976).

Table 24. Percentage of adipose clipped coho in the purse seine catch at grouped stations, 1975 and 1976.

Date	Head of Bay				Edge of Bay				Outside Bay			
	1975		1976		1975		1976		1975		1976	
	Percent Marked	Total Catch	Percent Marked	Total Catch	Percent Marked	Total Catch	Percent Marked	Total Catch	Percent Marked	Total Catch	Percent Marked	Total Catch
Apr 16-30	-	-			-	-						
May 1-15	-	152			-	-						
16-31	6.[illegible]	32	14.3	7	-	42	-	21				
Jun 1-15	2.75	109	-	46	8.33	96	13.33	15	1.23	163	4.17	24
16-30	4.53	243	4.88	41	6.71	149	-	2	6.43	249	-	-
Jul 1-15	3.56	365	8.33	144	3.73	268	10.90	156	4.55	220	4.29	70
16-31	3.70	621	9.47	264	7.41	27	7.00	100	5.13	117	6.90	232
Aug 1-15			6.25	32			5.75	87			13.16	38
16-31			13.71	124			9.96	231			12.23	229
Sep 1-15			10.39	308			9.17	109			8.75	80
16-30			7.10	155			10.53	19			6.96	230
Oct 1-15			11.31	168			16.67	6			7.61	92
16-31			2.94	68			0.00	1			16.67	6
Total	3.42	1522	9.06	1357	5.15	582	8.97	747	4.53	749	8.39	1001

Table 25. Percentage of marked coho in the catch at each purse seine station inside Cowichan Bay, 1975 and 1976.*

Station	1975		1976	
	Percent Marked	Total Catch	Percent Marked	Total Catch
1	-	69	4.05	74
2	4.17	144	16.67	138
2.5			7.53	93
3	4.15	193	9.59	490
3.5			10.17	59
4	2.57	623	5.46	165
4.5			-	8
5	3.40	411	10.40	173
6	5.08	295	9.31	462
6.5			8.06	310
7	5.18	193	2.86	35
8	8.52	176	6.19	97
9			-	7
10			11.11	9
Total	5.61	2,104	12.88	2,120

* Source: Appendix Tables 14-17.

Table 26. Percentage of coho with CWTs (released from Rotary Park and Kelvin Creek) in catches by purse seine in 1975 and 1976 at the same head, edge and all outside Cowichan Bay stations.*

Years	Grouped Stations			
	Head	Edge	Outside Total	Totals
July 1975	2.7%	2.4%	2.7%	2.6%
July 1976	3.9%	4.9%	1.4%	3.0%
Total	3.0%	2.8%	2.1%	2.8%

* Source: Appendix Table 31.

Table 27. Percentage of coho with CWTs (released from Rotary Park, Kelvin Creek, Mesachie Creek) in coho catches by purse seine in 1976 at all head, edge and outside Cowichan Bay stations.*

	Grouped Stations			
Months	Head	Edge	Outside Total	Totals
Jul-Aug	7.1%	6.8%	6.8%	6.9%
Sep-Oct	6.5%	6.9%	5.5%	6.2%
Total	6.8%	6.8%	6.3%	6.6%

* Source: Appendix Table 32.

Table 28. Percentage of the purse seine catch of each marked group of 1974 brood coho that was taken inside Cowichan Bay.*

Release Time	Release Location		
	Lower	Upper	Totals
Early	61.5%	65.8%	64.1%
Late	75.0%	58.8%	70.6%
Total	72.0%	62.5%	68.4%

* Source: Appendix Table 30.

Table 29. Fork length (cm) of CWT coho recaptured at age 1.1 in Cowichan Bay during October of their final ocean year.*

CWT Group	Early Release			Late Release		
	Average	Standard Deviation	Sample Size	Average	Standard Deviation	Sample Size
Lower River 1975	63.5	2.40	6	57.8	6.65	6
Lower River 1976	66.4	5.56	22	64.3	3.61	24
Upper River 1976	65.9	4.48	37	64.8	3.58	16

* Source: Lister, Thorson and Wallace (1981).

Table 30. Food items recorded from chinook stomachs sampled inside Cowichan Bay in 1973, in order of weight percentage.

Item Number	Item Group*	Computer Code	Prey Item	Weight Percentage
1	2	111	Herring (Clupea harengus pallasi)	54.3
2	3	131	Pulmonata	22.1
3	1	149	Tunicates (Tunicata)	9.2
4	2	120	Unidentified fish larvae	4.9
5	4	72	Crab megalops (Decapoda)	1.4
6	6	101	Hymenoptera (Insecta)	1.2
7	3	122	Mysids (Mysidae)	1.2
8	4	71	Crab zoea (Decapoda)	1.0
9	6	97	Homoptera (Insecta)	0.8
10	1	1	Calanus glacialis (Copepoda)	0.8
11	3	51	Anisogammarus sp. (Amphipoda)	0.6
12	1	48	Parasitic copepod (Copepoda)	0.5
13	1	14	Epilabidocera sp. (Copepoda)	0.4
14	6	96	Chironomid larvae (Insecta)	0.2
15	6	90	Diptera (Insecta)	0.2
16	2	114	Eulachon (Thaleichthys pacificus)	0.2
17	1	53	Parathemisto pacifica (Amphipoda)	0.2
18	1	5	Metridia lucens (Coelenterata)	0.1
19	4	69	Shrimp zoea and megalops (Decapoda)	0.1
20	1	75	Euphausia pacifica (Euphausiacea)	0.1
21	3	52	Corophium sp. (Amphipoda)	0.1
22	6	109	Insect larvae (Insecta)	0.1
23	3	125	Unidentified polychaete (Polychaeta)	0.1
24	1	2	Calanus plumchrus (Copepoda)	0.1
25	3	70	Shrimp (Decapoda)	
			Total Stomachs:	630
			Percentage Empty:	7.8%

* Food items were combined into habitat groups (see text and Appendix Table 37) in other analyses.

Table 31. Frequency of occurrence of food items recorded in stomachs from marked chinook caught by purse seine inside Cowichan Bay in 1976, in order of frequency of occurrence.

Item Number	Item Group*	Computer Code	Prey Item	Frequency of Occurrence: Number of Stomachs	Frequency of Occurrence: Percent of Stomachs
1	2	096	Herring (Clupea harengus pallasi)	97	32.12
2	4	YJ2	Porcellana zoea (Decapoda)	87	28.81
3	6	Y55	Diptera (Insecta)	62	20.53
4	4	XS2	Crab megalops (Decapoda)	50	16.56
5	6	Z00	Homoptera (Insecta)	36	11.92
6	1	RP0	Calanus marshallae (Copepoda)	34	11.26
7	6	Y70	Hymenoptera (Insecta)	33	10.93
8	3	WW3	Anisogammarus confervicolus (Amphipoda)	28	9.27
9	6	Z40	Arachnids (Arachnida)	25	8.28
10	4	XS1	Brachyuran zoea (Decapoda)	25	8.28
11	6	Y80	Psocoptera (Insecta)	23	7.62
12	6	Y30	Coleoptera (Insecta)	17	5.63
13	3	PR0	Polychaetes (Polychaeta)	15	4.97
14		P00	Nematodes (Nematoda)	14	4.64
15	1	XG9	Parathemisto (Amphipoda)	9	2.98
16	1	UH0	Epilabidocera amphitrites (Copepoda)	8	2.65
17	6	Y58	Diptera pupae (Insecta)	8	2.65
18		700	?	7	2.32
19	6	Z05	Hemiptera (Insecta)	6	1.99
20	3	WW6	Corophium (Amphipoda)	6	1.99
21	3	UY0	Harpacticoid copepods (Copepoda)	5	1.66
22	1	WQ0	Isopods (Isopoda)	4	1.32
23	6	Y00	Isoptera (Insecta)	4	1.32
24	3	WW0	Anisogammarus (Amphipoda)	4	1.32
25	1	XN0	Euphausia pacifica (Euphausiacea)	4	1.32
26	1	XG5	Hyperoche (Amphipoda)	3	0.99
27		YS2	?	3	0.99
28	?	RP7	Cenosphaera (?)	3	0.99
29		Y57	?	3	0.99
30	3	WW7	Corophium spinicorne (Amphipoda)	2	0.66
31	6	Y50	Lepidoptera (Insecta)	2	0.66
32		WW2	Amphipod (Amphipoda)	2	0.66
33		YH0	Shrimp (Decapoda)	2	0.66
34	3	XJ5	Caprellid amphipod (Amphipoda)	2	0.66
35		YZ0	?	1	0.33
36	3	WA0	Mysid (Mysidae)	1	0.33
37		X31	?	1	0.33
38	3	RG2	Philomedes (Ostracoda)	1	0.33
39	1	RK5	Parasitic Copepod	1	0.33
40		ZV5	?	1	0.33
41	6	Y63	Chironomid larvae (Insecta)	1	0.33
42	6	Z41	Pycnogonida (Arachnida)	1	0.33
43		WT0	?	1	0.33
44	1	XE0	Hyperid Amphipod (Amphipoda)	1	0.33
45	6	Y95	Thysanoptera (Insecta)	1	0.33
46		999	?	1	0.33
47	5	D64	Unidentified Egg	1	0.33
48	1	XF4	Primno (Amphipoda)	1	0.33
49	2	097	Herring larvae (Clupea harengus pallasi)	1	0.33
50	2	455	Sablefish (Anoplopoma fimbria)	1	0.33
51		RL0	Anthocyrtium (?)	1	0.33
52		XM6	?	1	0.33
53		YU0	?	1	0.33
54		YS5	?	1	0.33
55	1	RM6	Calanus pacificus (Copepoda)		

Total Stomachs: 302
Percentage empty: 17.9

* Food items were combined into habitat groups (see text and Appendix Table 38) in other analyses.

Table 32. Food items recorded from stomachs of marked chinook salmon caught by purse seine inside Cowichan Bay in 1976, in order of numeric frequency.

Item Number	Item Group*	Computer Code	Prey Item	Number of Prey
1	4	YJ2	Porcellana zoea (Decapoda)	1836
2	3	PR0	Polychaetes (Polychaeta)	1140
3	6	Y55	Diptera (Insecta)	524
4	1	XS2	Crab megalops (Decapoda)	504
5	1	RP0	Calanus marshallae (Copepoda)	374
6	6	Y80	Psocoptera (Insecta)	178
7	2	096	Herring (Clupea harengus pallasi)	134
8	3	UY0	Harpacticoid copepods (Copepoda)	98
9	1	XS1	Brachyuran zoea (Decapoda)	89
10	6	Y70	Hymenoptera (Insecta)	85
11	3	WW3	Anisogammarus confervicolus (Amphipoda)	84
12	6	Z00	Homoptera (Insecta)	75
13	6	Z40	Arachnids (Arachnida)	44
14		RL0	Anthocyrtium (?)	33
15	1	XG9	Parathemisto (Amphipoda)	29
16	6	Y30	Coleoptera (Insecta)	27
17		RP7	Cenosphaera (?)	18
18		P00	Nematodes (Nematoda)	15
19	6	Y58	Diptera pupae (Insecta)	15
20	1	XN0	Euphausia pacifica (Euphausiacea)	14
21		ZV5	?	12
22	6	Z05	Hemiptera (Insecta)	12
23	1	UH0	Epilabidocera amphitrites (Copepoda)	10
24		700	?	10
25	3	WW6	Corophium (Amphipoda)	8
26	3	WW0	Anisogammarus (Amphipoda)	7
27	3	RG2	Philomedes (Ostracoda)	6
28	3	WW7	Corophium spinicorne (Amphipoda)	5
29	3	YH0	Shrimp (Decapoda)	5
30	6	Y00	Isoptera (Insecta)	4
31	2	097	Herring larvae (Clupea harengus pallasi)	4
32	1	XG5	Hyperoche (Amphipoda)	4
33		Y57	?	4
34	6	Y63	Chironomid larvae (Insecta)	4
35	1	WQ0	Isopods (Isopoda)	4
36	3	XJ5	Caprellid amphipod (Amphipoda)	3
37	1	RM6	Calanus pacificus (Copepoda)	3
38		WW2	Amphipod (Amphipoda)	3
39	2	455	Sablefish (Anoplopoma fimbria)	3
40	1	XN8	Thysanoessa raschii (Euphausiacea)	3
41	6	Y50	Lepidoptera (Insecta)	2
42	1	XF4	Primno (Amphipoda)	2
43		YU0	?	2
44	5	D64	Unidentified Egg	1
45		YZ0	?	1
46	1	XE0	Hyperid Amphipod (Amphipoda)	1
47		X31	?	1
48		WT0	?	1
49		YS5	?	1
50	3	WA0	Mysid (Mysidae)	1
51	6	Y95	Thysanoptera (Insecta)	1
52		XM6	?	1
53		999	?	1
54	6	Z41	Pycnogonida (Arachnida)	1
55	1	RK5	Parasitic Copepod	1

Total Stomachs: 302
Percentage empty: 17.9

* Food items were combined into habitat groups (see text and Appendix Table 38) in other analyses.

Table 33. Food items recorded from coho stomachs sampled inside Cowichan Bay in 1973, in order of weight percentage.

Item Number	Item Group*	Computer Code	Prey Item	Weight Percentage
1	2	111	Herring (Clupea harengus pallasi)	77.2
2	4	71	Crab zoea (Decapoda)	5.5
3	2	120	Unidentified fish larvae	5.0
4	4	72	Crab megalops (Decapoda)	3.8
5	1	1	Calanus glacialis (Copepoda)	2.6
6	2	112	Salmon (Oncorhynchus sp.)	1.4
7	1	54	Cyphocaris challengeri	1.0
8	4	69	Shrimp zoea and megalops (Decapoda)	0.7
9	3	51	Anisogammarus sp. (Amphipoda)	0.6
10	1	53	Parathemisto pacifica (Amphipoda)	0.5
11	6	101	Hymenoptera (Insecta)	0.4
12	1	75	Euphausia pacifica (Euphausiacea)	0.2
13	6	90	Diptera (Insecta)	0.2
14	3	122	Mysids (Mysidae)	0.2
15	3	23	Harpacticoid copepod (Copepoda)	0.1
16	3	52	Corophium sp. (Amphipoda)	0.1
17	6	96	Chironomid larvae (Insecta)	0.1
18	6	97	Homoptera (Insecta)	0.1
19	1	149	Tunicates (Tunicata)	0.1
			Total Stomachs:	505
			Percentage Empty:	5.7%

* Food items were combined into habitat groups (see text and Appendix Table 37) in other analyses.

Table 34. Frequency of occurrence of food items recorded from stomachs of marked coho caught by purse seine inside Cowichan Bay in 1976, in order of frequency of occurrence.

Item Number	Item Group*	Computer Code	Prey Item	Frequency of Occurrence: Number of Stomachs	Frequency of Occurrence: Percent of Stomachs
1	2	096	Herring (Clupea harengus pallasi)	104	52.79
2	4	XS1	Brachyuran zoea (Decapoda)	23	11.68
3		P00	Nematodes (Nematoda)	19	9.64
4	4	YJ2	Porcellana zoea (Decapoda)	18	9.14
5	4	XS2	Crab megalops (Decapoda)	13	6.60
6	6	Y70	Hymenoptera (Insecta)	11	5.58
7	1	XG9	Parathemisto (Amphipoda)	10	5.08
8	7	700	?	8	4.06
9	6	Y55	Diptera (Insecta)	7	3.55
10	1	RK5	Parasitic Copepod (Copepoda)	7	3.55
11	6	Z00	Homoptera (Insecta)	4	2.03
12	1	XG5	Hyperoche (Amphipoda)	4	2.03
13	6	Y80	Psocoptera (Insecta)	3	1.52
14	1	XN0	Euphausia pacifica (Euphausiacea)	2	1.02
15	3	WW3	Anisogammarus confervicolus (Amphipoda)	2	1.02
16	6	Z40	Arachnids (Arachnida)	2	1.02
17	6	Y30	Coleoptera (Insecta)	1	0.51
18	1	XM0	Euphausiids (Euphausiacea)	1	0.51
19	6	Y00	Isoptera (Insecta)	1	0.51
20		WT0	?	1	0.51
21	3	PR0	Polychaetes (Polychaeta)	1	0.51
22	1	RPD	Calanus (Copepoda)	1	0.51
23	6	Z05	Hemiptera (Insecta)	1	0.51
24	3	WW7	Corophium spinicorne (Amphipoda)	1	0.51
25	1	430	Rockfish (Sebastes sp.)	1	0.51
26	1	097	Herring larvae (Clupea harengus pallasi)	1	0.51
27	1	XF4	Primno (Amphipoda)	1	0.51
			Total Stomachs	197	
			Percentage Empty	23.4	

* Food items were combined into habitat groups (see text and Appendix Table 38) in other analyses.

Table 35. Food items recorded from stomachs of marked coho caught by purse seine inside Cowichan Bay in 1976, in order of numerical frequency.

Item Number	Item Group*	Computer Code	Prey Item	Numbers of Prey
1	4	XS1	Brachyuran zoea (Decapoda)	705
2	4	YJ2	Porcellana zoea (Decapoda)	473
3	2	096	Herring (Clupea harengus pallasi)	394
4	4	XS2	Crab megalops (Decapoda)	262
5	1	XG9	Parathemisto (Amphipoda)	83
6	6	Y70	Hymenoptera (Insecta)	37
7		P00	Nematodes (Nematoda)	24
8	6	Y55	Diptera (Insecta)	21
9		700	?	10
10	1	RK5	Parasitic Copepod (Copepoda)	8
11	1	XG5	Hyperoche (Amphipoda)	5
12	6	Z00	Homoptera (Insecta)	5
13	3	WW3	Anisogammarus confervicolus (Amphipoda)	5
14	6	Y80	Psocoptera (Insecta)	3
15	6	Y00	Isoptera (Insecta)	2
16	1	XN0	Euphausia pacifica (Euphausiacea)	2
17	3	PR0	Polychaetes (Polychaeta)	2
18	6	Z40	Arachnids (Arachnida)	2
19		WT0	?	1
20	3	WW7	Corophium spinicorne (Amphipoda)	1
21	1	XF4	Primno (Amphipoda)	1
22	1	RPD	Calanus (Copepoda)	1
23	1	XM0	Euphausiids (Euphausiacea)	1
24	6	Z05	Hemiptera (Insecta)	1
25	6	Y30	Coleoptera (Insecta)	1
26	2	430	Rockfish (Sebastes sp.)	1
27	2	097	Herring larvae (Clupea harengus pallasi)	1

Total Stomachs 197
Percentage Empty 23.4

* Food items were combined into habitat groups (see text and Appendix Table 38) in other analyses.

Table 36. Monthly stomach contents in weight percentage for chinook caught inside Cowichan Bay in 1973.

Group Number	Diet Item	Weight Percentage	Diet Item	Weight Percentage
	MARCH		JULY	
1	Marine Zooplankton	6.6%	Marine Zooplankton	12.2%
2	Larval and Juvenile Fishes	85.6%	Larval and Juvenile Fishes	58.7%
3	Estuarine Benthic Organisms	7.8%	Estuarine Benthic Organisms	4.3%
4	Larvae of Benthos	0.1%	Larvae of Benthos	20.7%
5	Various Eggs	-	Various Eggs	<0.1%
6	Insects	-	Insects	4.2%
	Sample Size	3	Sample Size	190
	% Empty Stomachs	-	% Empty Stomachs	6.8%
	Content Weight/Fish (mg)	269.6	Content Weight/Fish (mg)	64.6
	APRIL		AUGUST	
1	Marine Zooplankton	31.3%	Marine Zooplankton	0.2%
2	Larval and Juvenile Fishes	15.8%	Larval and Juvenile Fishes	56.7%
3	Estuarine Benthic Organisms	45.3%	Estuarine Benthic Organisms	42.1%
4	Larvae of Benthos	1.4%	Larvae of Benthos	0.9%
5	Various Eggs	-	Various Eggs	-
6	Insects	6.3%	Insects	-
	Sample Size	8	Sample Size	120
	% Empty Stomachs	12.5%	% Empty Stomachs	11.7%
	Content Weight/Fish (mg)	51.5	Content Weight/Fish (mg)	890.6
	MAY		SEPTEMBER	
1	Marine Zooplankton	19.9%	Marine Zooplankton	43.2%
2	Larval and Juvenile Fishes	72.8%	Larval and Juvenile Fishes	50.0%
3	Estuarine Benthic Organisms	4.1%	Estuarine Benthic Organisms	0.1%
4	Larvae of Benthos	1.2%	Larvae of Benthos	0.8%
5	Various Eggs	-	Various Eggs	-
6	Insects	2.1%	Insects	5.8%
	Sample Size	37	Sample Size	55
	% Empty Stomachs	8.1%	% Empty Stomachs	1.8%
	Content Weight/Fish (mg)	139.3	Content Weight/Fish (mg)	772.1
	JUNE		TOTAL	
1	Marine Zooplankton	4.1%	Marine Zooplankton	11.2%
2	Larval and Juvenile Fishes	78.4%	Larval and Juvenile Fishes	59.5%
3	Estuarine Benthic Organisms	8.6%	Estuarine Benthic Organisms	24.2%
4	Larvae of Benthos	3.2%	Larvae of Benthos	2.5%
5	Various Eggs	<0.1%	Various Eggs	<0.1%
6	Insects	5.8%	Insects	2.6%
	Sample Size	217	Sample Size	630
	% Empty Stomachs	7.8%	% Empty Stomachs	7.8%
	Content Weight/Fish (mg)	155.8	Content Weight/Fish (mg)	320.3

Table 37. Monthly stomach contents in weight percentage for coho caught inside Cowichan Bay in 1973.

Group Number	Diet Item	Weight Percentage	Diet Item	Weight Percentage
	MARCH		JULY	
1	Marine Zooplankton	-	Marine Zooplankton	0.6%
2	Larval and Juvenile Fishes	-	Larval and Juvenile Fishes	53.9%
3	Estuarine Benthic Organisms	95.7%	Estuarine Benthic Organisms	0.3%
4	Larvae of Benthos	-	Larvae of Benthos	44.9%
5	Various Eggs	-	Various Eggs	-
6	Insects	4.3%	Insects	0.2%
	Sample Size	1	Sample Size	105
	% Empty Stomachs	-	% Empty Stomachs	1.9%
	Content Weight/Fish (mg)	7.2	Content Weight/Fish (mg)	189.8
	APRIL		AUGUST	
1	Marine Zooplankton	2.1%	Marine Zooplankton	1.8%
2	Larval and Juvenile Fishes	-	Larval and Juvenile Fishes	94.5%
3	Estuarine Benthic Organisms	69.4%	Estuarine Benthic Organisms	0.1%
4	Larvae of Benthos	-	Larvae of Benthos	3.5%
5	Various Eggs	-	Various Eggs	-
6	Insects	28.6%	Insects	-
	Sample Size	10	Sample Size	74
	% Empty Stomachs	-	% Empty Stomachs	14.9%
	Content Weight/Fish (mg)	16.0	Content Weight/Fish (mg)	1390.9
	MAY		SEPTEMBER	
1	Marine Zooplankton	28.8%	Marine Zooplankton	0.3%
2	Larval and Juvenile Fishes	49.1%	Larval and Juvenile Fishes	91.9%
3	Estuarine Benthic Organisms	7.6%	Estuarine Benthic Organisms	-
4	Larvae of Benthos	12.2%	Larvae of Benthos	0.7%
5	Various Eggs	-	Various Eggs	-
6	Insects	2.4%	Insects	7.0%
	Sample Size	175	Sample Size	15
	% Empty Stomachs	3.4%	% Empty Stomachs	-
	Content Weight/Fish (mg)	102.5	Content Weight/Fish (mg)	681.7
	JUNE		TOTAL	
1	Marine Zooplankton	2.2%	Marine Zooplankton	4.4%
2	Larval and Juvenile Fishes	83.6%	Larval and Juvenile Fishes	83.5%
3	Estuarine Benthic Organisms	1.2%	Estuarine Benthic Organisms	1.1%
4	Larvae of Benthos	11.7%	Larvae of Benthos	10.1%
5	Various Eggs	-	Various Eggs	-
6	Insects	1.4%	Insects	0.9%
	Sample Size	125	Sample Size	505
	% Empty Stomachs	8.0%	% Empty Stomachs	5.7%
	Content Weight/Fish (mg)	192.0	Content Weight/Fish (mg)	346.9

Table 38. Monthly stomach contents in weight percentage and IRI for chinook caught inside Cowichan Bay in 1976.

Group Number	Diet Item	Weight Percentage	IRI
	JULY		
1	Marine Zooplankton	3.8%	803.21
2	Larval and Juvenile Fishes	85.9%	1954.12
3	Estuarine Benthic Organisms	0.9%	106.37
4	Larvae of Benthos	8.1%	3931.06
5	Various Eggs	-	-
6	Insects	1.3%	754.92
	Sample Size	98	
	% Empty Stomachs	5.1%	
	Content Weight/Fish (mg)	163.2	
	AUGUST		
1	Marine Zooplankton	<0.1%	1.10
2	Larval and Juvenile Fishes	96.1%	4362.36
3	Estuarine Benthic Organisms	3.0%	1274.98
4	Larvae of Benthos	0.5%	616.06
5	Various Eggs	-	-
6	Insects	0.3%	418.65
	Sample Size	103	
	% Empty Stomachs	19.4%	
	Content Weight/Fish (mg)	586.1	
	SEPTEMBER		
1	Marine Zooplankton	0.1%	66.99
2	Larval and Juvenile Fishes	98.4%	3246.37
3	Estuarine Benthic Organisms	0.3%	170.26
4	Larvae of Benthos	0.6%	982.04
5	Various Eggs	<0.1%	0.27
6	Insects	0.5%	1193.34
	Sample Size	60	
	% Empty Stomachs	28.4%	
	Content Weight/Fish (mg)	716.1	
	OCTOBER		
1	Marine Zooplankton	0.9%	86.05
2	Larval and Juvenile Fishes	97.7%	3721.32
3	Estuarine Benthic Organisms	0.5%	220.93
4	Larvae of Benthos	0.8%	1224.40
5	Various Eggs	-	-
6	Insects	0.3%	429.27
	Sample Size	41	
	% Empty Stomachs	29.3%	
	Content Weight/Fish (mg)	810.4	

Table 39. Monthly stomach contents in weight percentage and IRI for coho caught inside Cowichan Bay in 1976.

Group Number	Diet Item	Weight Percentage	IRI
	JULY		
1	Marine Zooplankton	0.3%	12.31
2	Larval and Juvenile Fishes	95.8%	5510.23
3	Estuarine Benthic Organisms	0.1%	1.47
4	Larvae of Benthos	3.9%	4049.45
5	Various Eggs	-	-
6	Insects	<0.1%	13.36
	Sample Size	57	
	% Empty Stomachs	10.5%	
	Content Weight/Fish (mg)	562.8	
	AUGUST		
1	Marine Zooplankton	0.1%	210.95
2	Larval and Juvenile Fishes	99.7%	5064.37
3	Estuarine Benthic Organisms	0.1%	2.88
4	Larvae of Benthos	0.1%	221.84
5	Various Eggs	-	-
6	Insects	0.7%	241.87
	Sample Size	60	
	% Empty Stomachs	35.0%	
	Content Weight/Fish (mg)	1015.1	
	SEPTEMBER		
1	Marine Zooplankton	<0.1%	59.81
2	Larval and Juvenile Fishes	100.0%	11947.95
3	Estuarine Benthic Organisms	-	-
4	Larvae of Benthos	<0.1%	98.56
5	Various Eggs	-	-
6	Insects	<0.1%	31.86
	Sample Size	56	
	% Empty Stomachs	21.4%	
	Content Weight/Fish (mg)	8687.2	
	OCTOBER		
1	Marine Zooplankton	0.1%	112.20
2	Larval and Juvenile Fishes	99.7%	4967.87
3	Estuarine Benthic Organisms	-	-
4	Larvae of Benthos	0.3%	2305.58
5	Various Eggs	-	-
6	Insects	-	-
	Sample Size	22	
	% Empty Stomachs	27.3%	
	Content Weight/Fish (mg)	1911.3	

Table 40. Estimated proportion of the monthly samples for stomach content analysis that were obtained by each sampling gear in 1973.

Month	Purse Seine	Beach Seine	Tow Net	Pole Seine	Sample Size	
					Estimated*	Actual
			CHINOOK			
Mar	100%	-	-	-	3	3
Apr	63%	38%	-	-	8	8
May	37%	46%	13%	4%	46	37
Jun	40%	34%	26%	-	223	217
Jul	59%	12%	28%	-	137	190
Aug	54%	46%	-	-	134	120
Sep	100%	-	-	-	40	55
			COHO			
Mar	-	100%	-	-	1	1
Apr	-	100%	-	-	13	10
May	49%	32%	11%	8%	166	175
Jun	50%	47%	-	2%	133	125
Jul	88%	12%	-	-	78	105
Aug	100%	-	-	-	65	74
Sep	100%	-	-	-	40	15

* See text for estimation method.

Table 41. Summary of stomach contents for all marked chinook and coho caught inside and outside Cowichan Bay in 1976. N is numerical percentage, F is frequency of occurrence, W is weight percentage and IRI is index of relative importance.

Diet Item	Chinook - Inside Bay N	F	W	IRI
Polychaetes	21.15	4.97	1.18	110.94
Copepods	9.95	14.24	0.41	147.39
Amphipods	2.71	14.90	0.33	45.34
Euphausiids	0.33	2.32	0.22	1.28
Decapods*	45.07	36.09	1.46	1679.48
Insects	18.09	32.12	0.47	596.03
Herring	2.49	32.12	95.90	3160.19
Other	0.20	2.32	0.03	0.55

	Predator		Prey
Sample Size	302	Numbers/Fish	17.8
Mean Length (mm)	131.1	Weight/Fish (mg)	505.1
Mean Weight (g)	31.9		
% Empty Stomachs	17.9		

Diet Item	Coho - Inside Bay N	F	W	IRI
Polychaetes	0.10	0.51	<0.005	0.05
Copepods	0.05	0.51	<0.005	0.03
Amphipods	4.73	6.60	0.03	31.42
Euphausiids	0.15	1.02	0.01	0.16
Decapods*	71.71	18.78	0.24	1351.44
Insects	3.59	9.65	0.01	34.70
Herring	19.67	53.30	99.70	6362.46
Other	-	-	-	-

	Predator		Prey
Sample Size	197	Numbers/Fish	10.2
Mean Length (mm)	188.7	Weight/Fish (mg)	3155.1
Mean Weight (g)	97.9		
% Empty Stomachs	23.4		

Diet Item	Chinook - Outside Bay N	F	W	IRI
Polychaetes	-	-	-	-
Copepods	-	-	-	-
Amphipods	37.31	12.50	2.55	498.28
Euphausiids	32.84	12.50	7.01	498.04
Decapods*	4.48	25.00	0.08	114.03
Insects	20.90	25.00	0.67	539.18
Herring	4.48	37.50	89.69	3531.30
Other	-	-	-	-

	Predator		Prey
Sample Size	8	Numbers/Fish	8.4
Mean Length (mm)	162.2	Weight/Fish (mg)	499.1
Mean Weight (g)	56.1		
% Empty Stomachs	0.0		

Diet Item	Coho - Outside Bay N	F	W	IRI
Polychaetes	-	-	-	-
Copepods	0.03	1.16	<0.005	0.04
Amphipods	12.66	15.12	0.41	197.51
Euphausiids	-	-	-	-
Decapods*	82.79	40.70	0.91	3406.67
Insects	0.74	4.65	0.01	3.50
Herring	3.77	61.63	98.67	6313.48
Other	-	-	-	-

	Predator		Prey
Sample Size	86	Numbers/Fish	39.1
Mean Length (mm)	213.4	Weight/Fish (mg)	2585.2
Mean Weight (g)	139.0		
% Empty Stomachs	11.6		

* Zoea and megalops larval stages.

Table 42. Comparison of marked chinook and coho stomach contents between edge and head of bay capture locations in July and August 1976. Head and edge sample sizes were equal each month. N is numerical percentage, F is frequency of occurrence, W is weight percentage, and IRI is index of relative importance.

Diet Item	Chinook - Head of Bay N	F	W	IRI
Polychaetes	38.79	10.91	3.73	463.80
Copepods	9.47	17.27	0.74	176.24
Amphipods	2.19	14.55	0.59	40.32
Euphausiids	0.08	1.82	0.05	0.24
Decapods*	33.00	42.73	1.79	1486.34
Insects	14.30	40.00	0.58	595.24
Herring	1.92	32.73	92.49	3089.49
Other	0.27	2.73	0.04	0.85

Predator			Prey
Sample Size	110	Numbers/Fish	23.7
Mean Length (mm)	112.7	Weight/Fish (mg)	395.0
Mean Weight (g)	19.7		
% Empty Stomachs	7.3		

Diet Item	Coho - Head of Bay N	F	W	IRI
Polychaetes	0.27	1.92	0.02	0.56
Copepods	-	-	-	-
Amphipods	0.82	1.92	0.10	1.77
Euphausiids	0.27	1.92	0.23	0.96
Decapods*	87.04	25.00	2.24	2231.98
Insects	6.69	19.23	0.15	131.48
Herring	4.91	42.31	97.26	4322.74
Other	-	-	-	-

Predator			Prey
Sample Size	52	Numbers/Fish	14.1
Mean Length (mm)	168.3	Weight/Fish (mg)	620.1
Mean Weight (g)	66.5		
% Empty Stomachs	21.2		

Diet Item	Chinook - Edge of Bay N	F	W	IRI
Polychaetes	-	-	-	-
Copepods	16.11	33.33	1.21	577.16
Amphipods	1.23	6.25	0.15	8.64
Euphausiids	0.34	4.17	0.51	3.50
Decapods*	69.24	52.08	3.81	3804.46
Insects	11.07	27.08	0.42	311.32
Herring	1.90	25.00	93.91	2395.23
Other	0.11	2.08	<0.005	0.23

Predator			Prey
Sample Size	48	Numbers/Fish	18.6
Mean Length (mm)	119.6	Weight/Fish (mg)	330.9
Mean Weight (g)	25.2		
% Empty Stomachs	22.9		

Diet Item	Coho - Edge of Bay N	F	W	IRI
Polychaetes	-	-	-	-
Copepods	0.16	2.50	<0.005	0.42
Amphipods	0.99	7.50	0.07	7.88
Euphausiids	-	-	-	-
Decapods*	88.34	27.50	1.21	2462.57
Insects	0.82	10.00	<0.005	8.25
Herring	9.69	55.00	98.72	5962.50
Other	-	-	-	-

Predator			Prey
Sample Size	40	Numbers/Fish	15.2
Mean Length (mm)	166.4	Weight/Fish (mg)	1105.5
Mean Weight (g)	66.7		
% Empty Stomachs	20.0		

* Zoea and megalops larval stages.

Table 43. Monthly stomach contents for marked chinook caught inside Cowichan Bay in 1976. N is numerical percentage, F is frequency of occurrence, W is weight percentage and IRI is index of relative importance.

Diet Item	JULY N	F	W	IRI
Polychaetes	-	-	-	-
Copepods	21.37	40.82	3.82	1028.16
Amphipods	1.86	10.20	0.66	25.66
Euphausiids	0.12	2.04	0.50	1.27
Decapods*	60.52	61.22	8.91	4251.09
Insects	14.76	44.90	1.34	722.72
Herring	1.09	22.45	84.65	1924.78
Other	0.28	3.06	0.12	1.23

Predator			Prey
Sample Size	98	Numbers/Fish	25.3
Mean Length (mm)	95.8	Weight/Fish (mg)	163.2
Mean Weight (g)	10.4		
% Empty Stomachs	5.1		

Diet Item	SEPTEMBER N	F	W	IRI
Polychaetes	3.47	1.67	0.16	6.04
Copepods	0.99	5.00	0.02	5.05
Amphipods	8.25	23.33	0.24	198.10
Euphausiids	-	-	-	-
Decapods*	45.22	21.67	0.63	993.24
Insects	37.62	31.67	0.49	1206.89
Herring	4.13	31.67	98.44	3247.93
Other	0.33	3.33	0.03	1.19

Predator			Prey
Sample Size	60	Numbers/Fish	10.1
Mean Length (mm)	154.8	Weight/Fish (mg)	716.1
Mean Weight (g)	46.3		
% Empty Stomachs	28.3		

Diet Item	AUGUST N	F	W	IRI
Polychaetes	56.63	11.65	2.68	691.00
Copepods	-	-	-	-
Amphipods	1.62	12.62	0.38	25.29
Euphausiids	0.11	1.94	0.04	0.29
Decapods*	22.27	25.24	0.45	573.57
Insects	15.73	24.27	0.33	389.78
Herring	3.58	40.78	96.12	4065.39
Other	0.06	0.97	<0.005	0.05

Predator			Prey
Sample Size	103	Numbers/Fish	17.3
Mean Length (mm)	136.9	Weight/Fish (mg)	586.1
Mean Weight (g)	33.8		
% Empty Stomachs	19.4		

Diet Item	OCTOBER N	F	W	IRI
Polychaetes	20.74	4.88	0.35	102.85
Copepods	-	-	-	-
Amphipods	4.07	19.51	0.22	83.61
Euphausiids	2.52	7.32	0.70	23.55
Decapods*	49.61	24.39	0.78	1229.06
Insects	19.38	21.95	0.25	430.92
Herring	3.49	34.15	97.65	3453.46
Other	0.19	2.44	0.06	0.61

Predator			Prey
Sample Size	41	Numbers/Fish	12.6
Mean Length (mm)	166.2	Weight/Fish (mg)	810.4
Mean Weight (g)	57.1		
% Empty Stomachs	29.3		

* Zoea and megalops larval stages.

Table 44. Monthly stomach contents for marked coho caught inside Cowichan Bay in 1976. N is numerical percentage, F is frequency of occurence, W is weight percentage and IRI is index of relative importance.

Diet Item	JULY N	JULY F	JULY W	JULY IRI
Polychaetes	0.16	1.75	0.02	0.32
Copepods	0.08	1.75	<0.005	0.15
Amphipods	0.16	1.75	0.07	0.41
Euphausiids	0.16	1.75	0.23	0.69
Decapods*	92.77	42.11	3.86	4068.65
Insects	1.07	12.28	0.03	13.42
Herring	5.59	54.39	95.79	5513.49
Other	-	-	-	-

Predator			Prey
Sample Size	57	Numbers/Fish	21.4
Mean Length (mm)	147.0	Weight/Fish (mg)	562.8
Mean Weight (g)	42.2		
% Empty Stomachs	10.5		

Diet Item	AUGUST N	AUGUST F	AUGUST W	AUGUST IRI
Polychaetes	-	-	-	-
Copepods	-	-	-	-
Amphipods	26.58	6.67	0.15	178.21
Euphausiids	-	-	-	-
Decapods*	33.33	6.67	0.08	222.77
Insects	18.14	13.33	0.07	242.89
Herring	21.94	41.67	99.70	5068.29
Other	-	-	-	-

Predator			Prey
Sample Size	60	Numbers/Fish	4.0
Mean Length (mm)	189.9	Weight/Fish (mg)	1015.1
Mean Weight (g)	93.1		
% Empty Stomachs	35.0		

Diet Item	SEPTEMBER N	SEPTEMBER F	SEPTEMBER W	SEPTEMBER IRI
Polychaetes	-	-	-	-
Copepods	-	-	-	-
Amphipods	5.04	7.14	0.01	36.07
Euphausiids	0.28	1.79	<0.005	0.50
Decapods*	18.49	5.36	0.02	99.12
Insects	4.48	7.14	<0.005	32.04
Herring	71.71	69.64	99.97	11956.38
Other	-	-	-	-

Predator			Prey
Sample Size	56	Numbers/Fish	6.4
Mean Length (mm)	215.2	Weight/Fish (mg)	8687.2
Mean Weight (g)	136.3		
% Empty Stomachs	21.4		

Diet Item	OCTOBER N	OCTOBER F	OCTOBER W	OCTOBER IRI
Polychaetes	-	-	-	-
Copepods	-	-	-	-
Amphipods	6.09	18.18	0.08	112.20
Euphausiids	-	-	-	-
Decapods*	84.26	27.27	0.27	2305.58
Insects	-	-	-	-
Herring	9.65	45.46	99.65	4967.87
Other	-	-	-	-

Predator			Prey
Sample Size	22	Numbers/Fish	9.0
Mean Length (mm)	235.0	Weight/Fish (mg)	1911.3
Mean Weight (g)	165.7		
% Empty Stomachs	27.3		

* Zoea and megalops larval stages.

Table 45. Comparison of stomach contents of coho and chinook salmon caught inside Cowichan Bay (see text section 4.6.3). N is numerical percentage, F is frequency of occurence, W is weight percentage and IRI is index of relative importance.

Diet Item	Coho - Similar Length N	F	W	IRI
Polychaetes	0.58	3.85	0.04	2.37
Copepods	0.29	3.85	0.01	1.14
Amphipods	0.86	3.85	0.03	3.41
Euphausiids	-	-	-	-
Decapods*	82.18	26.92	1.77	2260.29
Insects	11.21	26.92	0.23	307.81
Herring	4.89	38.46	97.93	3954.51
Other	-	-	-	-

Predator			Prey
Sample Size	26	Numbers/Fish	13.4
Mean Length (mm)	162.1	Weight/Fish (mg)	629.5
Mean Weight (g)	59.3		
% Empty Stomachs	19.2		

Diet Item	Coho - Random Length N	F	W	IRI
Polychaetes	-	-	-	-
Copepods	-	-	-	-
Amphipods	-	-	-	-
Euphausiids	-	-	-	-
Decapods*	58.43	7.69	0.25	451.36
Insects	2.25	7.69	<0.005	17.31
Herring	39.33	57.69	99.74	8023.23
Other	-	-	-	-

Predator			Prey
Sample Size	26	Numbers/Fish	3.4
Mean Length (mm)	194.2	Weight/Fish (mg)	1892.8
Mean Weight (g)	105.7		
% Empty Stomachs	30.8		

Diet Item	Chinook - Similar Length N	F	W	IRI
Polychaetes	-	-	-	-
Copepods	2.46	7.69	0.04	19.25
Amphipods	-	-	-	-
Euphausiids	-	-	-	-
Decapods*	82.76	23.08	1.16	1936.60
Insects	3.45	11.54	0.08	40.73
Herring	11.33	53.85	98.72	5925.75
Other	-	-	-	-

Predator			Prey
Sample Size	26	Numbers/Fish	7.8
Mean Length (mm)	155.3	Weight/Fish (mg)	681.8
Mean Weight (g)	49.8		
% Empty Stomachs	23.1		

Diet Item	Chinook - Random Length N	F	W	IRI
Polychaetes	16.29	3.85	1.11	66.91
Copepods	0.98	11.54	0.09	12.28
Amphipods	1.79	19.23	0.64	46.77
Euphausiids	-	-	-	-
Decapods*	49.51	30.77	3.21	1622.08
Insects	30.13	42.31	1.15	1323.23
Herring	1.30	34.62	93.81	3292.34
Other	-	-	-	-

Predator			Prey
Sample Size	26	Numbers/Fish	23.6
Mean Length (mm)	126.3	Weight/Fish (mg)	365.3
Mean Weight (g)	26.3		
% Empty Stomachs	11.5		

* Zoea and megalops larval stages.

Table 46. Comparison of juvenile chinook and coho smolt population estimates. July CWT recoveries and non-CWT catch from stations inside Cowichan Bay.

	Chinook Catch Year/ Brood Year		Coho Catch Year/ Brood Year	
	1975/1974	1976/1975	1975/1973	1976/1974
July CWT recoveries	11	93	26	26
July non-CWT catch	1,128	1,034	1,255	638
Number CWTs released+	16,554	16,003	16,448	21,978
Est. of Pop. Size	1,557,550	176,214	765,183	520,170
95 % confidence interval	2,365,898 802,171	187,107 165,635	871,728 436,785	948,958 410,660
Prev. Pop. Estimates*	581,000	172,300	NA	1,649,500
95 % confidence interval	658,000 517,000	207,000 152,000		3,130,000 961,500
Estimated Survival of CWTs: to Escapement, to catch & escape.+	0.3% 6.1%	0.4% 6.0%	1.5% 21.1%	4.3% 13.6%
Total Escapement**	9,158	9,483	27,022	69,115
Est. of Pop. Size from escapement/cwt survival to escape.++	3,100,000	2,400,000	1,800,000	1,600,000

* Source: Armstrong and Argue (1977); Argue, Patterson and Armstrong (1979).
** Source: Lister, Thorson and Wallace (1981).
+ Source: Data in Table 10 for lower river coho CWTs, and estuary chinook CWTs.

Table 47. Comparison of coho smolt population estimates based on 1976 CWT releases, CWT recoveries and non-CWT catch from stations inside Cowichan Bay.*

	June	July	August	September	October	Average
			Coho Lower River Releases			
CWT recoveries	2	26	22	24	13	
non-CWT catch	102	638	452	567	230	
Number CWTs released	21,978	21,978	21,978	21,978	21,978	
Estimated Pop. Size	754,612	520,170	432,891	499,363	362,654	453,769
95 % confidence interval	11,319,185 314,422	826,152 369,594	721,485 299,894	810,654 350,676	735,819 227,675	
			Coho Upper River Releases			
CWT recoveries	-	15	14	14	2	
non-CWT catch	104	649	460	577	241	
Number CWTs released	38,913	38,913	38,913	38,913	38,913	
Estimated Pop. Size	-	1,580,881	1,195,957	1,499,486	3,139,063	1,853,847
95 % confidence interval	- -	3,011,202 1,019,923	2,329,786 763,377	2,921,077 957,119	47,085,940 1,307,943	

* Source: CWT recoveries from Appendix Table 28; catch from Appendix Table 16; mark releases from Table 10.

Table 48. Comparison of average fork length (mm) of chinook and coho caught in Cowichan Bay and in Georgia Strait by purse seine.*

	Chinook		Coho		
Month	Cowichan Inside	Georgia Strait	Cowichan Inside	Cowichan Outside	Georgia Strait
July	100	150	146	167	200
August	133	191	187	201	250
September	158	224	215	241	276
October	168	250	224	263	301

* Source: Cowichan data averaged from biweekly sample mean lengths in Appendix Tables 33 and 35; Georgia Strait data from 1965 to 1971 sampling data summarized by Argue et al. (1983).

APPENDIX TABLES

Appendix Table 1. Beach seine catch of chinook juveniles, 1973.*

Date	Beach Seine Station										Total
	1	1.5	2	2.5	3	4	4.5	5	6	7	
Mar 22	**		-		**	-		-	-	**	-
Apr 5	-		-		-	-		-	**	-	-
18	-		-		-	-		-	-	-	-
May 7	-		1		-	2		-	-	-	3
16	-		-		-	-		1		-	1
30	-		3		1	-		3	24	-	31
Jun 12		2		6			-				8
13	3		5		3	10		-	1	-	5
25	6		1		-	2		1			17
26							-		3	-	10
27		1		8			-				3
Jul 12	-	-		13	-	-					9
13			-				-	2	3	-	13
26		-		-	-	-				-	5
27	1		-		-	-		1	-		-
Aug 8	-		-		-	-					2
9								-	-		-
22	-		-		-	-					-
23								-	-	-	-
Total	10	3	10	27	4	14	-	8	31	-	107

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught.
** Salmonid fry captured but not identified to species.

Appendix Table 2. Tow net catch of chinook juveniles, 1973.*

Date	Tow Net Station 1	2	3	4	Total
Apr 4	-	-			-
18	-	-			-
May 3	-	-	-	-	-
15	-	1	-	-	1
31	2	-	-	3	5
Jun 11	3	91	64	45	203
26	8	7	-	16	31
Jul 11	4	6	14	11	35
25	-	1	1	7	9
Aug 7	3	3	4	52	62
Total	20	109	83	134	346

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught.

Appendix Table 3. Pole seine catch of chinook juveniles, 1973.*

Date	Pole Seine Station 1	2	3	4	5	6	7	Total
Apr 18			-	-				-
May 8	-	-	-	-	-			-
15	-	-	-	-	-			-
31	-	-	2	-	-			2
Jun 12			-	-		-	-	-
27			-			-	-	-
Jul 12			-				-	-
26			-					-
Total	-	-	2	-	-	-	-	2

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught.

Appendix Table 3a. Purse seine catch of chinook inside Cowichan Bay, 1973.*

Date	Purse Seine Station 1	2	3	4	5	Total
Mar 8	-	-	-	-	-	-
21	-	-	2	1	-	3
Apr 4-8	-	-	1	-	1	2
18	1	-	-	2	-	3
May 2-8	-	-	-	-	-	-
15-16	-	3	2	1	-	6
29-31	-	19	-	1	-	20
Jun 11-13	159	108	139	11	5	422
25-27	4	900	23	16	12	955
Jul 10-13	475	82	650	215	1	1,423
25-27	33	23	22	79	-	157
Aug 7-8	57	138	5	30	-	230
21-23	206	37	7	45	-	295
Sep 4-5	349	55	36	82	-	522
Total	1,284	1,365	887	483	19	4,038

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught.

Appendix Table 4. Beach seine catch of chinook juveniles, 1975.*

		Beach Seine Station																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
April	30	-	-		8			-													8
May	1	-						18													18
	15	-			23	1		90													114
	16		-																		-
	26				16	21		25													62
	27	-	1																		1
June	5		-		7			115	25	-	30	15	10	10		-	-				212
	"															-					-
	6	-																-	-		-
	12	-	-		67	44		54										-	-	-	165
	"		-																		-
	13	-																1			1
	26	6	19		7	3		34		6		34								-	109
July	10	-								1		1								-	2
	11		1					-													1
	24	-	-		-	2		-		-		-								-	2
Total		6	21	-	128	71	-	336	25	7	30	50	10	10	-	-	-	1	-	-	695

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught. There were no marked chinook in the beach seine catch.

Appendix Table 5. Purse seine catch of chinook inside Cowichan Bay, 1975.*

Date	Purse Seine Station								Total
	1	2	3	4	5	6	7	8	
Apr 29	3	–	–	4	–	8	–	–	15
30	–	1	–	6	–	–	–	–	7
May 13			–	–	–	–			–
"			–	–	–	–			–
14	–	–					–	–	–
"	–	–					–	–	–
26			–	–	–	–			–
27	–	–	–	2	1	–	–	–	3
28	–	–					7	3	10
Jun 9			–	–	2	–			2
10	–	–	2	–	16	31	1	22	72
11	5	–					9	25	39
23	5	11							16
24			7	300	400	200			907
"			15	10	9	60			94
25	–	1					90	110	201
"							47	57	104
Jul 7	–	3					4	1	8
8	–	–	10	13	35	15	125	12	210
9			1	45	26	75			147
21			175	75	150	30			430
22	–	30	33	80	4	110	19	1	277
23	–	15					50	1	66
Total	13	61	243	535	643	529	352	232	2608

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught. Thirty-seven chinook in their second ocean year (age 0.1) were caught but are not included in this table or in any analyses.

Appendix Table 6. Purse seine catch of marked chinook inside Cowichan Bay, 1975.*

Date	Purse Seine Station								Total
	1	2	3	4	5	6	7	8	
Apr 29	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-
May 13			-	-	-	-			-
"			-	-	-	-			-
14	-	-					-	-	-
"	-	-					-	-	-
26			-	-	-	-			-
27	-	-	-	-	-	-	-	-	-
28	-	-					-	-	-
Jun 9			-	-	-	-			-
10	-	-	-	-	-	-	-	-	-
11	-	-					-	-	-
23	-	-							-
24			-	-	-	-			-
"			-	-	-	-			-
25	-	-					-	-	-
"							-	-	-
Jul 7	-	-					-	-	-
8	-	-	-	-	-	-	-	-	-
9			-	-	-	2			2
21			3	-	1	-			4
22	-	-	-	-	1	6	2	1	10
23	-	-					2	-	2
Total	-	-	3	-	2	8	4	1	18

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught. The following marks were not returned to the laboratory: 1 from station 5 (21 July); 3 from station 6 (22 July).

Appendix Table 7. Purse seine catch of chinook inside Cowichan Bay, 1976.*

Date	Purse Seine Station													
	1	2	2.5	3	3.5	4	4.5	5	6	6.5	7	8	9	10	Total
May 27	4	-		-		-		8	3		-	2	-	-	17
Jun 9	-	-		1		2		-	1		1	2	-	-	7
10						-			-						-
21				12		3		1	4		4			1	25
22	-	3			8		1		4			-	-		16
"									2						2
"									4						4
Jul 5				44		77		32	6		6	5	-		170
6	1	8												-	9
7				24				5		37					66
"				16				6		13					35
"				10				5		28					43
8				22		7	5		23	18					75
"				43		6				57					106
"				34		15									49
9										58					58
"										46					46
19										1					1
20		-		19				11	32	17					79
"		3							113	43					159
"									10						10
21	3	8		45		-		1	98		15	16	-	-	186
23				28											28
"				7											7
Aug 5										58					58
6	1	3		19		5		6	140		11	28	-	-	213
18	22	63		5		3		34	13		45	6	-	-	191
20	19	76	287						118		28				528
"			72												72
31	10	143		20		5		21	43		14	10	-	-	266
Sep 1						27		76	59						162
2		62		15		45			13						135
"				22											22
"				28											28
14	3	1		37		6		9	58	32	21	4	-	-	171
"									42						42
15					57										57
17				15	11				28						54
27				47		5			16						68
"				41											41
28	1	1		15		4		5	1		42	6	-	-	75
"				11					9						20
"				22											22
29				15						7					22
30				27											27
Oct 1				22					18						40
"				44											44
12				64					12						76
"				35											35
13	1	2		8		1		-	1		40	2	-	-	55
"				1											1
"				34											34
15				54		24									78
"				14											14
16				31	24										55
"				28											28
25				13											13
"				14											14
"				5											5
26	-	-		3		4		1	2		10	-	-	1	21
27				19		-			-						19
"				15											15
28				9		-		-		1					10
"				5				-							5
Total	65	373	359	1062	100	239	6	221	873	416	237	81	-	2	4034

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught.

Appendix Table 8. Purse seine catch of marked chinook inside Cowichan Bay, 1976.*

Date	Purse Seine Station													Total
	1	2	2.5	3	3.5	4	4.5	5	6	6.5	7	8	9	10	
May 27	-	-		-		-		-	-		-	-	-	-	-
Jun 9	-	-		-		-		-	-		-	-	-	-	-
10						-			-						-
21				-		-		-	-		-			-	-
22	-	-			-		-		-			-	-		-
"									-						-
"									-						-
Jul 5				5		9		3	1		-	1	-		19
6	-	-												-	-
7				1				1		4					6
"				-				-		3					3
"				1				-		2					3
8				3		1	4		8	1					17
"				1		-				4					5
"				4		-									4
9										1					1
"										7					7
19										-					-
20		-		3				-	2	1					6
"		-							5	-					5
"									1						1
21	-	-		1		-		-	15		-	-	-	-	16
23				3											3
"				2											2
Aug 5										7					7
6	-	-		-		-		1	15		1	-	-	-	17
18	-	3		-		1		8	2		4	-	-	-	18
20	2	5	11						10		1				29
"			5												5
31	-	7		2		2		3	6		-	-	-	-	20
Sep 1						-		5	7						12
2		3		1		1			-						5
"				1											1
"				1											1
14	-	-		6		-		-	6	1	4	-	-	-	17
"									1						1
15					2										2
17				3	-				2						5
27				3		-			1						4
"				4											4
28	-	-		2		-		-	-		3	-	-	-	5
"				1					-						1
"				1											1
29				1						-					1
30				-											-
Oct 1				1					4						5
"				4											4
12				3					1						4
"				3											3
13	-	-		-		-		-	-		3	-	-	-	3
"				3											3
"				-											-
15				2		-									2
"				-											-
16				2	2										4
"				4											4
25				1											1
"				1											1
"				-											-
26	-	-		-		-		1	-		2	-	-	-	3
27				1		-			-						1
"				2											2
28				1		-		-		-					1
"				-				-							-
Total	2	18	16	78	4	14	4	22	87	31	18	1	-	-	295

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught. One mark caught from set one at station 5 (20 Aug) was not returned to the laboratory.

Appendix Table 9. Beach seine catch of coho salmon juveniles, 1973.*

Date	Beach Seine Station 1 Smolt	1 Fry	1.5 Fry	2 Smolt	2 Fry	2.5 Fry	3 Smolt	3 Fry	4 Smolt	4 Fry	4.5 Fry	5 Fry	6 Smolt	6 Fry	7 Fry	7.5	Total Smolt	Total Fry
Mar 22	-	-		-	-		-	1	-	-		-	-	-	-		-	1
Apr 5	-	-		-	-		-	-	-	5		-	-	5	3		-	13
18	-	-		-	-		-	-	-	-		-	-	-	-		-	-
May 7	-	-		-	-		1	-	-	2			-	1	2		1	5
16	-	-		-	-		-	-	-	4		-			3		-	7
30	5	3		-	5		-	2	-			1	8	61	6		13	78
Jun 12			2	-	1	-					5						-	8
13	1	1					-	-	1	31		-	2	5	1		4	38
25	3	2		3	-		-	-	-	2		-	24	35	1		30	40
27			-			3					-						-	3
Jul 12	-	-	-			-					9						-	9
13				-	-		-	-	-	-		-	-		-		-	-
26			-			-					-				-		-	-
27	-	-		-	-		-	-	-	-		-	-			-	-	-
Aug 8	-	-		-	-		-	-	-	-		-	-				-	-
9																	-	-
22	-	-		-	-		-	-	-	-		-	-				-	-
23																	-	-
Total	9	6	2	3	6	3	1	3	1	44	14	1	34	107	16	-	48	202

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught. Stations 1.5, 2.5, 4.5, and 7.5 were fished with a hand hauled beach seine (called a "manual beach seine" in field records) because they were in shallow water near pole seine stations.

Appendix Table 10. Tow net catch of coho juveniles, 1973.*

	Tow Net Station									
	1		2		3		4		Total	
Date	Smolt	Fry	Smolt	Fry	Smolt	Fry	Smolt	Fry	Smolt	Fry
Apr 4	-	-	-	-					-	-
18	-	-	-	-					-	-
May 3	-	-	-	-	-	1	-	-	-	1
15	1	2	2	-	4	-	-	-	7	2
31	3	1	-	1	-	-	-	3	3	5
Jun 11	1	-	-	23	-	-	2	3	3	26
26	-	-	-	10	-	3	1	21	1	34
Jul 11	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-
Aug 7	-	-	-	-	-	-	-	-	-	-
Total	5	3	2	34	4	4	3	27	14	68

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught.

Appendix Table 11. Pole seine catch of coho fry, 1973.

	Pole Net Station							
Date	1	2	3	4	5	6	7	Total
Apr 18			-	-				-
May 8	-	-	1	-	-			1
15	-	-	-	-	-			-
31	1	1	18	-	-			20
Jun 12			1	-		-	2	3
27			-			-	-	-
Jul 12			-				-	-
26			-			-		-
Total	1	1	20	0	-	-	2	24

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught.

Appendix Table 11a. Purse seine catch of coho inside Cowichan Bay, 1973.*

Date	Purse Seine Station 1	2	3	4	5	Total
Mar 8	-	-	-	-	-	-
21	-	-	-	-	-	-
Apr 4-8	-	-	-	-	-	-
18	-	-	-	-	-	-
May 2-8	-	-	-	-	-	-
15-16	1	23	16	25	14	79
29-31	5	55	6	12	47	125
Jun 11-13	2	33	61	5	2	103
25-27	502	750	44	6	2	1,304
Jul 10-13	12	1	454	2	6	475
25-27	12	256	92	56	-	416
Aug 7-8	6	58	1	10	2	77
21-23	41	13	9	7	-	70
Sep 4-5	72	24	15	29	-	140
Total	653	1,213	698	152	73	2,789

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught.

Appendix Table 12. Beach seine catch of coho smolts and fry, 1975.*

Date	Beach Seine Station																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
Apr 30	-	1		-			-													1
May 1	-						1													1
15	1			15	-		6													22
16		31																		31
26				13	-		29													42
27	-	-																		-
Jun 5		16		-			-	15	1(1)	2	(5)	-	1		-	1				36(6)
"															-					
6	15																			
12	1	-		1	-		2(1)										13	1		29
"		2															-	-	-	4(1)
13	8																			2
26	1	1		-	1		1		-		-						-			8
Jul 10	-								(2)		1(3)								-	4
11		-					-												-	1(5)
24	-	-		-	-		(3)		-		-								-	-
Total	26	51	-	29	1	-	39(4)	15	1(3)	2	1(8)	-	1	-	-	1	13	1	-	181(15)

* Catches of fry are shown in brackets. Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught.

Appendix Table 13. Beach seine catch of marked coho smolts, 1975.*

Date	Beach Seine Station																			Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Apr 30	-	-		-			-													-
May 1	-						-													-
15	-			-	-		-													-
16		1																		1
26				1	-		2													3
27	-	-																		-
Jun 5		-		-			-	-	-	-	-	-	1		-	-				1
"															-					-
6	-																1	-		1
12	-	-		-	-		-										-	-	-	-
"		1																		1
13	-																-			-
26	-	-		-	-		-		-		-								-	-
Jul 10	-								-		-								-	-
11		-					-													-
24	-	-		-	-		-		-		-								-	-
Total	-	2	-	1	-	-	2	-	-	-	-	-	1	-	-	-	1	-	-	7

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught.

Appendix Table 14. Purse seine catch of coho inside Cowichan Bay, 1975.*

Date	Purse Seine Station								Total
	1	2	3	4	5	6	7	8	
Apr 29	–	–	–	–	–	–	–	–	–
30	–	–	–	–	–	–	–	–	–
May 13			–	152	–	–			152
"			–	–	–	–			–
14	–	–					–	–	–
"	–	–					–	–	–
26			–	–	–	–			–
27	4	–	–	7	–	25	4	–	40
28	1	–					27	6	34
Jun 9			2	–	3	40			45
10	–	–	1	–	44	19	6	21	91
11	4	8					27	30	69
23	2	7							9
24			15	3	20	19			57
"			72	24	19	71			186
25	–	12					8	96	116
"							24	–	24
Jul 7	40	18					12	1	71
8	11	90	17	17	80	50	80	16	361
9			19	135	19	28			201
21			45	100	220	20			385
22	5	6	22	185	6	23	2	5	254
23	2	3					3	1	9
Total	69	144	193	623	411	295	193	176	2104

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught. Sixty-two first ocean year coho were caught but are not included in this table or in any analyses.

Appendix Table 15. Purse seine catch of marked coho inside Cowichan Bay, 1975.*

Date	Purse Seine Station								Total
	1	2	3	4	5	6	7	8	
Apr 29	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-
May 13			-	-	-	-			-
"			-	-	-	-			-
14	-	-					-	-	-
"	-	-					-	-	-
26			-	-	-	-			-
27	-	-	-	-	-	2	-	-	2
28	-	-					-	-	-
Jun 9			-	-	-	2			2
10	-	-	-	-	1	-	-	4	5
11	-	-					3	1	4
23	-	-							-
24			-	-	1	2			3
"			4	-	1	3			8
25	-	1					-	7	8
"							3	-	3
Jul 7	-	1					-	-	1
8	-	3	1	-	5	3	4	2	18
9			-	4	-	1			5
21			3	4	4	-			11
22	-	1	-	8	2	2	-	1	14
23	-	-					-	-	-
Total	-	6	8	16	14	15	10	15	84

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught. The following marks were not returned to the laboratory: 2 from station 8 (10 June); 1 from station 7 (11 June); 1 from station 3 (24 June); 2 from station 6 (24 June); 5 from station 8 (25 June); 1 from station 5 (8 July); 4 from station 4 (21 July); 4 from station 4, (22 July).

Appendix Table 16. Purse seine catch of coho inside Cowichan Bay, 1976.*

Date	Purse Seine Station														
	1	2	2.5	3	3.5	4	4.5	5	6	6.5	7	8	9	10	Total
May 27	14	-		-		-		-	7		-	7	3	-	31
Jun 9	5	2		-		7		7	3		1	7	4	7	43
10						13			16						29
21				16		7		1	2		-			1	27
22	1	1			7		5		1			-	-		15
"									1						1
"									1						1
Jul 5				6		25		13	11		3	3	-		61
6	6	4												1	11
7				4				3		45					52
"				11				13		11					35
"				9				4		16					29
8				8		4	3		2	17					34
"				6		5				27					38
"				15		2									17
9										15					15
"										9					9
19										3					3
20		3		10				4	12	9					38
"		8							99	41					148
"									11						11
21	9	7		20		3		2	75		3	17	-	-	136
23				22											22
"				6											6
Aug 5										57					57
6	4	-		4		2		2	24		1	25	-	-	62
18	9	4		6		3		-	2		1	2	-	-	27
20	22	21	79						52		2				176
"			14												14
31	2	53		15		-		26	20		4	18	-	-	138
Sep 1						11		73	34						118
2		33		2		45			1						81
"				7											7
"				21											21
14	2	1		18		2		20	21	56	11	6	-	-	137
"									14						14
15					39										39
17				23	5				38						66
27				24		4			6						34
"				8											8
28	-	-		2		4		5	5		7	8	-	-	31
"				10					1						11
"				5											5
29				3						4					7
30				12											12
Oct 1				15					3						18
"				14											14
12				14					-						14
"				16											16
13	-	1		5		2		-	-		2	3	-	-	13
"				7											7
"				7											7
15				47		22									69
"				16											16
16				19	8										27
"				9											9
25				6											6
"				5											5
"				1											1
26	-	-		-		4		-	-		-	1	-	-	5
27				6		-			-						6
"				9											9
28				-		-		-		-					-
"				1				-							1
Total	74	138	93	490	59	165	8	173	462	310	35	97	7	9	2120

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught.

Appendix Table 17. Purse seine catch of marked coho inside Cowichan Bay, 1976.*

Date	Purse Seine Station													Total
	1	2	2.5	3	3.5	4	4.5	5	6	6.5	7	8	9	10	
May 27	-	-		-		-		-	1		-	-	-	-	1
Jun 9	1	-		-		-		-	-		-	1	-	1	3
10						-			-						-
21				1		-		-	-		-			-	1
22	-	-			-		-		-			-	-		-
"									1						1
"									-						-
Jul 5				2		-		1	-		-	-	-		3
6	-	-												-	-
7				1				2		5					8
"				1				-		2					3
"				-				-		1					1
8				2		-	-		1	2					5
"				1		-				3					4
"				-		1									1
9										-					-
"										2					2
19										-					-
20		1		1				-	13	2					17
"		2							2	-					4
"									-						-
21	-	1		-		1		-	3		-	1	-	-	6
23				5											5
"				-											-
Aug 5										4					4
6	-	-		-		-		1	1		-	1	-	-	
18	-	2		1		-		-	1		-	-	-	-	
20	1	5	7						5		-				18
"			-												-
31	-	7		3		-			3		-	1	-	-	18
Sep 1						1		8	5						14
2		5		-		5			-						10
"				3											3
"				-											-
14	1	-		-		-		2	1	3	1	-	-	-	8
"									1						1
15					6										6
17				2	-				4						6
27				3		-			-						3
"				1											1
28	-	-		-		-		-	-		-	1	-	-	1
"				-					-						-
"				-											-
29				1						1					2
30				-											-
Oct 1				1					1						2
"				4											4
12				-					-						-
"				3											3
13	-	-		-		1		-	-		-	1	-	-	2
"				-											-
"				3											3
15				5		-									5
"				1											1
16				-	-										-
"				-											-
25				-											-
"				1											1
"				-											-
26	-	-		-		-		-	-		-	-	-	-	-
27				-		-			-						-
"				1											1
28				-		-		-		-					-
"				-				-							-
Total	3	23	7	47	6	9	-	18	43	25	1	6	-	1	189

* Each data entry at each station represents a single set. A dash indicates that a set was made but no fish were caught. The following marks were not returned to the laboratory: all 4 marks on 27 May and 9 June; one from set 2, station 6.5 (7 July); one from set one, station 6.5 (8 July).

Appendix Table 18. Purse seine catch and mark recoveries of coho and chinook for stations outside Cowichan Bay, 1975.*

Date	Purse Seine Station	Coho		Chinook	
		Total	Marked	Total	Marked
Jun 12	B13	23	-	7	-
"	B13	15	1	10	-
"	B17	100	1	12	-
"	B25	4	-	-	-
"	B29	21	-	-	-
23	B25	-	-	2	-
"	B29	14	1	4	-
"	C5	32	2	-	-
"	B13	11	-	35	-
"	B18	17	1	55	-
26	B6	19	-	-	-
"	B10	71	6	1	-
"	B15	48	2	17	-
"	B20	-	-	-	-
"	C12	19	2	1	-
"	C13	17	2	-	-
"	C30	1	-	-	-
Jul 7	B29	13	1	65	-
"	C5	57	-	-	-
"	C6	4	-	-	-
8	B13	7	1	14	-
"	B17	15	-	6	-
"	B23	51	3	4	-
9	B2	-	-	-	-
"	B5	35	1	-	-
"	B6	27	3	39	-
"	B15	1	-	-	-
10	C12	6	1	59	-
"	C22	-	-	-	-
"	C44	1	-	40	-
"	C48	-	-	-	-
"	D8	3	-	-	-
21	B29	18	1	425	11
"	C6	2	-	-	-
22	B23	2	-	-	-
"	B26	4	1	-	-
23	B6	2	-	-	-
"	B10	12	1	-	-
"	B14	-	-	-	-
"	B15	21	1	-	-
24	C14	19	1	1	-
"	C22	1	-	-	-
"	C39	7	-	6	-
"	C48	14	1	10	-
"	D7	15	-	-	-
Total		749	34	813	11

* Each data row represents a single set. The following marks were not returned to the laboratory: 4 coho from station B10 (26 June); 1 coho from station C12 (26 June); 5 chinook from station B29 (21 July). Three chinook in their second ocean year (age 0.1) and three coho in their second ocean year (age 1.1) were caught but not included in

Appendix Table 19. Purse seine catch and mark recoveries of coho and chinook for stations outside Cowichan Bay, 1976.*

Date	Station	Coho		Chinook	
		Total	Marked	Total	Marked
Jun 10	B10	3	-	3	-
"	B17	1	-	-	-
"	B19	3	-	1	-
"	B22	15	1	-	-
"	B25	1	-	1	-
"	B35	1	-	3	-
Jul 6	C5	7	-	3	-
"	C6	60	2	7	-
"	C12	-	-	-	-
"	C22	3	1	-	-
21	B10	79	6	9	-
"	B15	8	1	-	-
"	B22	15	1	-	-
22	B29	21	3	5	-
"	C6	11	-	1	-
"	C12	-	-	-	-
"	C12	8	-	18	-
"	C15	2	-	-	-
"	C17	-	-	-	-
"	C23	86	5	4	-
"	C47	2	-	-	-
Aug 4**	B10	24	4	-	-
6	B29	14	1	5	-
17	B10	14	3	21	-
"	B10	119	19	79	1
"	B35	1	-	1	-
19	B10	11	1	26	1
"	B10	26	2	30	-
"	B21	14	1	-	-
"	B22	18	-	2	-
30	B10	5	1	15	1
"	B10	1	1	-	-
"	B21	20	-	15	-
Sep 1	A1	30	3	3	-
15	A1	15	-	2	-
"	B10	8	1	-	-
"	B10	21	3	6	-
"	B22	-	-	-	-
"	B22	6	-	1	-
16	B29	9	-	5	-
"	C5	25	2	11	-
"	C14	8	-	5	1
"	C15	61	4	17	-
"	C29	1	-	3	-
"	C35	-	-	-	-

Continued ...

Appendix Table 19. (Continued).

Sep 29	B5	7	-	1	-
"	B5	3	1	-	-
"	B10	8	1	2	-
"	B21	4	1	-	-
"	B22	4	-	-	-
"	B22	18	-	2	-
"	B23	26	3	27	1
"	B23	7	-	4	-
30	B13	13	2	-	-
"	C5	6	-	-	-
"	C5	14	2	3	1
"	C5	14	-	3	-
"	C10	2	-	1	-
Oct 14	S1	-	-	-	-
"	S1	-	-	-	-
"	S1	6	1	-	-
"	S1	3	-	1	-
"	S1	-	-	-	-
"	S1	2	1	-	-
"	S1	3	-	3	-
"	S1	1	-	1	-
15	A10	26	2	3	-
"	A10	4	-	1	1
"	A10	11	1	4	-
"	A10	32	2	4	-
"	A22	3	-	1	-
"	B23	1	-	1	-
27	B6	-	-	-	-
"	B6	3	-	-	-
"	B6	2	1	2	-
"	B15	-	-	-	-
28	C5	1	-	1	1
"	C5	-	-	-	-
Total		1001	84	367	8

* Each data row for each station represents a single set. Three chinook in their second ocean year (age 0.1) were caught but are not included in this table or in any analyses.

** Data sheet lost; it was assumed that there were six unmarked coho for every marked coho that was recovered. One coho mark caught at station B22 on 10 June was not returned to the laboratory.

Appendix Table 20. Chinook mark recoveries by purse seine in 1975. Recoveries sorted by CWT code and then by date of recovery.

Recapture Station	CWT Code	Recapture Date		Fork Length (mm)	Wet Weight (g)	Scale Number
		Calendar	Julian			
3	No Pin	Jul 21	202	99	11.28	624
B29	"	Jul 21	202	85	7.48	580
B29	"	Jul 21	202	99	13.14	578
7	"	Jul 22	203	114	19.14	693
7	"	Jul 23	204	130	26.34	730
6	6/2/5 +	Jul 9	190	72	4.19	NA
6	7/2/5	Jul 9	190	89	7.22	492
3	"	Jul 21	202	99	12.24	625
B29	"	Jul 21	202	96	10.97	579
B29	"	Jul 21	202	85	7.05	582
B29	"	Jul 21	202	109	12.02	577
3	"	Jul 21	202	95	10.94	623
B29	"	Jul 21	202	96	9.75	581
8	"	Jul 22	203	129	27.01	686
6	"	Jul 22	203	91	7.02	666
5	"	Jul 22	203	82	30.50	662
6	"	Jul 22	203	100	10.18	669
6	"	Jul 22	203	95	10.41	667
7	"	Jul 23	204	86	6.96	731
3*	8/2/5	Jun 10	161	330	NA	943
7	9/2/5 +	Jul 22	203	78	5.42	NA
6*	CAPILANO HATCH	May 27	147	300	NA	932
6*	PORTAGE BAY WA	Jun 10	161	355	NA	944

Total CWT's: 18 Total No Pins: 5 Total Pin Lost: 0 Grand Total: 23

+ It is assumed that these tags were misread and should be code 7/2/5.

* These 3 tagged fish were assumed to be from the 1973 brood year and were excluded from all analyses.

Appendix Table 21. Chinook mark recoveries by purse seine in 1976. Recoveries sorted by CWT code and then by date of recovery.

Recapture Station	CWT Code	Recapture Date		Fork Length (mm)	Wet Weight (g)	Stomach Weight (g)
		Calendar	Julian			
4	No Pin	Jul 5	187	78	4.93	0.22
3	"	Jul 5	187	79	4.62	0.12
3	"	Jul 8	190	84	6.21	0.32
6	"	Jul 21	203	108	13.14	0.31
3	"	Jul 23	205	104	13.01	0.50
B10	"	Aug 17	230	156	47.39	2.52
6	"	Aug 18	231	107	14.13	0.49
2.5	"	Aug 20	233	166	58.18	4.12
5	"	Aug 31	244	134	26.17	0.77
3	"	Sep 2	246	147	35.75	0.74
7	"	Sep 14	258	168	59.57	2.04
7	"	Sep 28	272	176	75.79	5.07
B23	"	Sep 29	273	163	46.10	2.11
3	"	Oct 12	286	147	37.03	1.20
3	"	Oct 15	289	170	54.65	1.08
3	"	Oct 27	301	175	64.73	2.50
6	"	Aug 6	219	131	28.26	0.70
6.5	Pin Lost	Aug 5	218	134	30.05	1.97
7	"	Aug 18	231	151	45.27	2.46
5	"	Sep 1	245	127	22.39	0.70
4	1/2/7	Jul 5	187	84	6.07	0.19
4	"	Jul 5	187	101	10.45	0.42
4	"	Jul 5	187	79	5.34	0.18
4	"	Jul 5	187	82	5.61	0.19
5	"	Jul 5	187	101	9.71	0.42
6	"	Jul 5	187	84	5.92	0.27
4	"	Jul 5	187	78	4.63	0.23
3	"	Jul 5	187	75	3.88	0.15
4	"	Jul 5	187	83	5.80	0.21
5	"	Jul 5	187	87	6.72	0.44
5	"	Jul 5	187	88	6.19	0.18
3	"	Jul 5	187	80	4.93	0.29
8	"	Jul 5	187	82	5.38	0.18
3	"	Jul 5	187	83	5.28	0.20
3	"	Jul 5	187	75	4.04	0.10
4	"	Jul 5	187	79	4.97	0.17
4	"	Jul 5	187	86	7.21	0.28
6.5	"	Jul 7	189	121	20.29	1.19
6.5	"	Jul 7	189	93	9.21	0.53
3	"	Jul 7	189	79	5.02	0.13
6.5	"	Jul 7	189	81	5.62	0.20
6.5	"	Jul 7	189	112	13.73	0.53
6.5	"	Jul 7	189	88	7.56	0.28
6.5	"	Jul 7	189	76	4.44	0.19
6.5	"	Jul 7	189	83	5.53	0.25
6.5	"	Jul 7	189	104	11.90	0.61
3	"	Jul 7	189	66	3.27	0.12
6.5	"	Jul 7	189	85	7.02	0.37
5	"	Jul 7	189	81	5.56	0.20
4	"	Jul 8	190	84	6.75	0.38
6.5	"	Jul 8	190	123	18.96	0.68
6	"	Jul 8	190	107	12.82	1.49
4.5	"	Jul 8	190	74	3.91	0.08
3	"	Jul 8	190	82	5.82	0.20
3	"	Jul 8	190	80	5.38	0.28

Continued ...

Appendix Table 21. (Continued).

6	"	Jul	8	190	112	15.44	1.20
4.5	"	Jul	8	190	76	4.31	0.19
3	"	Jul	8	190	92	7.42	0.28
6.5	"	Jul	8	190	109	11.65	0.49
3	"	Jul	8	190	90	7.05	0.25
6	"	Jul	8	190	83	5.50	0.24
6	"	Jul	8	190	79	4.43	0.23
6	"	Jul	8	190	87	5.89	0.29
4.5	"	Jul	8	190	92	8.02	0.43
4.5	"	Jul	8	190	125	19.45	0.44
6	"	Jul	8	190	75	3.98	0.15
6	"	Jul	8	190	89	6.53	0.31
6.5	"	Jul	8	190	92	8.14	0.59
6.5	"	Jul	8	190	118	18.77	0.95
6	"	Jul	8	190	83	5.71	0.28
3	"	Jul	8	190	80	5.44	0.24
3	"	Jul	8	190	75	4.76	0.15
6.5	"	Jul	8	190	85	6.13	0.31
3	"	Jul	8	190	77	4.63	0.26
6.5	"	Jul	9	191	110	10.15	0.46
6.5	"	Jul	9	191	77	4.86	0.21
6.5	"	Jul	9	191	81	5.51	0.23
6.5	"	Jul	9	191	86	6.31	0.25
6.5	"	Jul	9	191	88	6.36	0.28
6.5	"	Jul	9	191	109	13.17	0.33
6.5	"	Jul	9	191	85	6.33	0.29
6.5	"	Jul	9	191	90	6.83	0.23
6.5	"	Jul	20	202	94	8.41	0.25
6	"	Jul	20	202	92	7.89	2.32
3	"	Jul	20	202	124	22.30	1.53
6	"	Jul	20	202	113	16.07	0.49
6	"	Jul	20	202	110	16.02	0.48
3	"	Jul	20	202	111	16.61	0.77
6	"	Jul	20	202	111	17.65	1.53
6	"	Jul	20	202	101	11.21	0.30
6	"	Jul	20	202	95	9.38	0.38
6	"	Jul	20	202	94	8.81	0.46
3	"	Jul	20	202	90	7.22	0.39
6	"	Jul	20	202	134	26.73	0.84
6	"	Jul	21	203	128	23.44	0.59
6	"	Jul	21	203	91	7.32	0.42
3	"	Jul	21	203	119	20.81	0.88
6	"	Jul	21	203	142	32.52	1.45
6	"	Jul	21	203	93	8.28	0.30
6	"	Jul	21	203	118	17.57	0.66
6	"	Jul	21	203	87	7.08	0.37
6	"	Jul	21	203	109	14.98	0.45
6	"	Jul	21	203	119	19.32	0.75
6	"	Jul	21	203	117	17.39	0.81
6	"	Jul	21	203	149	37.38	2.57
6	"	Jul	21	203	133	28.77	1.72
6	"	Jul	21	203	102	12.04	0.74
6	"	Jul	21	203	109	13.36	0.55
6	"	Jul	21	203	126	24.07	1.84
3	"	Jul	23	205	95	8.84	0.30
3	"	Jul	23	205	100	10.80	0.47
3	"	Jul	23	205	119	19.72	0.70
3	"	Jul	23	205	123	20.83	1.07
7*+	"	Aug	5	218	135	28.56	1.43
6.5*+	"	Aug	5	218	152	50.68	2.09

Continued ...

Appendix Table 21. (Continued).

6.5	"	Aug	5	218	106	12.86	0.32
6.5	"	Aug	5	218	156	51.86	1.44
6.5	"	Aug	5	218	96	10.84	0.49
6*+	"	Aug	5	218	129	26.82	0.61
6*+	"	Aug	5	218	179	79.66	2.52
6*+	"	Aug	5	218	109	15.73	0.61
6.5	"	Aug	5	218	105	13.14	0.56
6*+	"	Aug	5	218	96	9.65	0.28
6.5	"	Aug	5	218	128	27.99	1.53
5*+	"	Aug	5	218	124	22.61	0.57
6.5	"	Aug	5	218	145	37.36	1.34
7*+	"	Aug	5	218	154	36.70	0.53
6	"	Aug	6	219	114	17.08	1.37
6	"	Aug	6	219	105	14.31	0.77
6	"	Aug	6	219	151	46.62	2.67
6	"	Aug	6	219	99	10.36	0.48
7	"	Aug	6	219	118	20.66	0.79
6	"	Aug	6	219	124	19.20	1.22
6	"	Aug	6	219	154	51.65	2.58
6	"	Aug	6	219	92	9.34	0.49
5	"	Aug	6	219	101	12.39	0.75
6	"	Aug	6	219	117	19.14	1.00
6	"	Aug	6	219	108	13.74	0.64
6	"	Aug	6	219	104	12.45	0.48
6	"	Aug	6	219	133	32.72	1.36
6	"	Aug	6	219	103	11.84	0.47
6	"	Aug	6	219	147	36.68	1.61
6	"	Aug	6	219	95	8.79	0.34
4	"	Aug	18	231	128	20.50	1.39
7	"	Aug	18	231	149	38.35	0.86
6	"	Aug	18	231	127	23.62	0.53
5	"	Aug	18	231	124	21.96	0.91
7	"	Aug	18	231	173	61.92	1.82
2	"	Aug	18	231	175	79.03	5.11
5	"	Aug	18	231	105	14.23	0.86
5	"	Aug	18	231	112	17.00	0.96
7	"	Aug	18	231	169	54.51	2.68
5	"	Aug	18	231	133	27.12	1.16
5	"	Aug	18	231	110	14.56	0.92
5	"	Aug	18	231	118	15.89	0.75
5	"	Aug	18	231	118	17.45	0.84
5	"	Aug	18	231	114	16.69	0.81
2	"	Aug	18	231	150	39.68	0.86
2	"	Aug	18	231	128	26.76	2.24
B10	"	Aug	19	232	123	21.82	0.73
2.5	"	Aug	20	233	140	31.61	0.61
6	"	Aug	20	233	124	22.69	0.79
2.5	"	Aug	20	233	164	64.71	3.68
2.5	"	Aug	20	233	163	49.83	1.74
6	"	Aug	20	233	162	49.79	1.32
2.5	"	Aug	20	233	122	21.66	0.57
6	"	Aug	20	233	140	33.95	1.60
2.5	"	Aug	20	233	146	34.13	0.87
2.5	"	Aug	20	233	149	37.71	0.82
2	"	Aug	20	233	117	18.28	0.71
2	"	Aug	20	233	134	26.28	0.51
2.5	"	Aug	20	233	160	48.19	3.37
2	"	Aug	20	233	124	22.05	0.46
2.5	"	Aug	20	233	113	14.93	0.96
2.5	"	Aug	20	233	115	17.63	0.56

Continued ...

Appendix Table 21. (Continued).

2.5	"	Aug 20	233	141	32.73	0.80
6	"	Aug 20	233	153	41.55	1.59
2	"	Aug 20	233	127	23.41	1.33
6	"	Aug 20	233	137	30.82	1.39
. 6	"	Aug 20	233	159	46.07	1.93
2	"	Aug 20	233	122	21.59	0.62
2.5	"	Aug 20	233	145	42.56	2.74
6	"	Aug 20	233	127	24.57	0.81
1	"	Aug 20	233	137	32.56	0.78
1	"	Aug 20	233	186	78.12	2.80
6	"	Aug 20	233	190	91.36	5.15
2.5	"	Aug 20	233	145	37.41	1.79
2.5	"	Aug 20	233	131	24.61	0.61
6	"	Aug 20	233	175	72.28	3.31
7	"	Aug 20	233	172	78.71	6.30
6	"	Aug 20	233	122	18.80	0.48
B10	"	Aug 30	243	119	21.00	1.48
6	"	Aug 31	244	151	37.13	1.03
2	"	Aug 31	244	156	49.36	1.15
2	"	Aug 31	244	143	30.91	0.88
6	"	Aug 31	244	137	27.04	0.65
2	"	Aug 31	244	192	87.60	2.48
2	"	Aug 31	244	146	39.38	3.16
3	"	Aug 31	244	169	53.62	1.19
2	"	Aug 31	244	154	40.21	1.93
5	"	Aug 31	244	155	41.98	1.72
6	"	Aug 31	244	122	23.30	0.65
6	"	Aug 31	244	186	83.16	6.23
5	"	Aug 31	244	145	31.52	0.87
2	"	Aug 31	244	182	71.52	1.65
4	"	Aug 31	244	122	19.61	0.71
3	"	Aug 31	244	134	29.47	1.93
6	"	Aug 31	244	141	28.39	0.71
4	"	Aug 31	244	140	29.70	1.04
2	"	Aug 31	244	165	54.13	1.17
6	"	Aug 31	244	151	32.81	1.95
6	"	Sep 1	245	112	16.42	0.67
5	"	Sep 1	245	146	29.90	0.84
6	"	Sep 1	245	142	38.29	0.95
5	"	Sep 1	245	126	22.38	0.89
6	"	Sep 1	245	147	40.37	0.80
5	"	Sep 1	245	176	60.46	2.35
6	"	Sep 1	245	123	26.32	1.24
6	"	Sep 1	245	111	16.40	0.48
6	"	Sep 1	245	121	19.54	0.69
5	"	Sep 1	245	152	40.91	1.57
6	"	Sep 1	245	174	81.85	5.93
2	"	Sep 2	246	127	25.51	0.63
4	"	Sep 2	246	156	47.26	1.18
2	"	Sep 2	246	136	28.64	0.70
2	"	Sep 2	246	151	43.59	0.95
3	"	Sep 2	246	130	26.46	1.59
3	"	Sep 2	246	143	35.39	0.86
6	"	Sep 14	258	130	25.43	0.93
6	"	Sep 14	258	132	24.82	0.79
6	"	Sep 14	258	146	37.22	1.60
6	"	Sep 14	258	125	23.74	1.44
3	"	Sep 14	258	167	59.57	1.79
3	"	Sep 14	258	169	51.65	4.24
6.5	"	Sep 14	258	115	15.93	0.55
3	"	Sep 14	258	148	42.09	2.35
3	"	Sep 14	258	170	67.73	2.01
6	"	Sep 14	258	149	36.62	0.91

Continued ...

Appendix Table 21. (Continued).

6	"	Sep 14	258	121	19.40	0.62
7	"	Sep 14	258	173	74.32	5.82
6	"	Sep 14	258	190	82.93	1.61
7	"	Sep 14	258	173	57.85	1.08
3	"	Sep 14	258	129	25.56	0.88
7	"	Sep 14	258	167	56.25	1.29
3	"	Sep 14	258	151	43.30	1.14
3.5	"	Sep 15	259	215	101.94	4.44
3.5	"	Sep 15	259	162	51.21	2.26
C14	"	Sep 16	260	164	57.81	1.94
3	"	Sep 17	261	174	66.82	3.40
3	"	Sep 17	261	133	26.00	0.84
6	"	Sep 17	261	155	45.52	2.42
3	"	Sep 17	261	146	37.88	1.74
6	"	Sep 17	261	176	76.76	2.02
3	"	Sep 27	271	119	21.71	0.98
3	"	Sep 27	271	146	34.24	3.05
3	"	Sep 27	271	169	64.72	2.69
3	"	Sep 27	271	161	56.53	2.87
3	"	Sep 27	271	261	35.46	0.80
3	"	Sep 27	271	187	90.58	5.93
6	"	Sep 27	271	177	67.42	1.62
7	"	Sep 28	272	183	77.68	5.47
3	"	Sep 28	272	160	44.85	2.91
3	"	Sep 28	272	170	55.37	1.24
3	"	Sep 28	272	159	44.96	1.66
3	"	Sep 28	272	150	36.83	1.14
7	"	Sep 28	272	198	87.85	1.70
3	"	Sep 29	273	160	43.99	1.12
C5	"	Sep 30	274	188	77.84	2.39
3	"	Oct 1	275	142	32.24	1.27
3	"	Oct 1	275	164	59.38	1.41
6	"	Oct 1	275	168	53.45	1.30
3	"	Oct 1	275	155	36.54	0.72
6	"	Oct 1	275	151	40.70	1.52
6	"	Oct 1	275	129	24.21	1.51
3	"	Oct 1	275	165	48.69	1.29
6	"	Oct 1	275	140	29.00	1.14
3	"	Oct 12	286	118	18.67	0.54
3	"	Oct 12	286	165	56.64	4.79
3	"	Oct 12	286	179	68.65	2.57
3	"	Oct 12	286	156	41.68	1.40
3	"	Oct 12	286	148	42.44	1.56
6	"	Oct 12	286	159	48.31	1.52
7	"	Oct 13	287	203	95.85	1.59
3	"	Oct 13	287	157	44.98	1.33
3	"	Oct 13	287	146	35.60	0.99
3	"	Oct 13	287	161	46.77	0.87
7	"	Oct 13	287	190	86.42	3.94
7	"	Oct 13	287	149	34.59	0.87
3	"	Oct 15	289	205	118.96	3.12
B10	"	Oct 15	289	187	74.74	2.25
3	"	Oct 16	290	179	76.40	2.08
3.5	"	Oct 16	290	170	63.76	5.78
3.5	"	Oct 16	290	172	59.24	3.79
3	"	Oct 16	290	192	79.62	1.58
3	"	Oct 16	290	176	64.92	2.87
3	"	Oct 16	290	178	68.51	1.39
3	"	Oct 16	290	196	87.05	2.20
3	"	Oct 16	290	185	78.19	2.69

Continued ...

Appendix Table 21. (Continued).

3	"	Oct 25	299	174	67.45	4.11
3	"	Oct 25	299	184	80.95	4.61
7	"	Oct 26	300	144	34.50	1.46
7	"	Oct 26	300	168	53.77	1.48
5	"	Oct 26	300	185	68.16	1.99
3	"	Oct 27	301	149	37.95	1.38
3	"	Oct 27	301	160	50.96	1.57
3	"	Oct 28	302	190	87.75	4.55
3*	13/3/2	Sep 27	271	180	73.50	3.96
C5*	13/6/3	Oct 28	302	198	101.98	3.87
2.5*	CAPILANO	Aug 20	233	133	29.21	1.27
3*	CAPILANO	Oct 1	275	171	60.94	5.45
5* **	DESCHUTES WA	Jul 5	187	234	153.60	3.47

Total CWT's: 291 Total No Pins: 17 Total Pin Lost: 3 Grand Total: 311

* These 13 tagged fish were excluded from CWT relative abundance analysis.
** This tagged fish was reported to be from the 1974 brood year and was excluded from all analyses.
\+ These 8 tagged fish were not recorded on the available field record sheets.

Appendix Table 22. Coho mark recoveries by purse seine (PS) and beach seine (bs) in 1975. Recoveries sorted by CWT code and then by date of recovery.

Recapture Station	Gear	CWT Code	Recapture Date		Fork Length (mm)	Wet Weight (g)	Scale Number
			Calendar	Julian			
7	bs	No Pin	May 26	146	100	12.60	40
7	bs	"	May 26	146	107	16.44	41
4	bs	"	May 26	146	89	10.41	45
7	PS	"	Jun 11	162	92	8.85	88
8	PS	"	Jun 11	162	102	14.18	95
B13	PS	"	Jun 12	163	113	17.27	105
3	PS	"	Jun 24	175	124	26.12	198
3	PS	"	Jun 24	175	126	27.07	199
3	PS	"	Jun 24	175	114	20.60	200
7	PS	"	Jun 25	176	120	22.66	264
B10	PS	"	Jun 26	177	158	60.84	289
4	PS	"	Jul 9	190	142	36.73	483
4	PS	"	Jul 9	190	200	109.47	486
B6	PS	"	Jul 9	190	153	59.72	524
B29	PS	"	Jul 21	202	130	31.75	576
5	PS	"	Jul 21	202	220	131.14	594
C14	PS	"	Jul 24	205	180	81.54	778
17*	bs	6/2/5	Jun 6	157	96	10.68	NA
C5	PS	"	Jun 23	174	135	32.57	349
5	PS	"	Jun 24	175	115	20.52	149
8	PS	"	Jun 25	176	119	22.17	246
C13	PS	"	Jun 26	177	130	27.71	320
2	PS	"	Jul 8	189	135	33.93	387
B14	PS	"	Jul 8	189	103	16.75	418
5	PS	"	Jul 8	189	185	87.74	448
7	PS	"	Jul 8	189	125	29.59	422
7	PS	"	Jul 8	189	140	34.35	420
6	PS	"	Jul 9	190	133	32.48	496
B6	PS	"	Jul 9	190	147	44.46	525
3	PS	"	Jul 21	202	148	45.13	619
C48	PS	"	Jul 24	205	171	65.66	756
6*	PS	7/2/5 +	Jun 24	175	104	14.15	171
2*	PS	" +	Jul 8	189	183	83.99	385
5	PS	9/2/5	Jun 10	161	102	12.10	67
8	PS	"	Jun 10	161	118	20.41	80
7	PS	"	Jun 11	162	101	11.18	89
2*	bs	"	Jun 12	163	94	10.84	108
B29	PS	"	Jun 23	174	100	12.04	127
6	PS	"	Jun 24	175	104	13.54	224
B18	PS	"	Jun 24	175	105	15.62	183
7	PS	"	Jun 25	176	118	21.68	263
7	PS	"	Jun 25	176	140	33.87	262
8	PS	"	Jun 25	176	108	14.92	245
C13	PS	"	Jun 26	177	106	14.69	319
B15	PS	"	Jun 26	177	113	18.90	312
B29	PS	"	Jul 7	188	143	37.53	117
6	PS	"	Jul 8	189	168	64.21	457
B23	PS	"	Jul 8	189	129	30.55	431
7	PS	"	Jul 8	189	172	81.35	419
3	PS	"	Jul 8	189	163	66.83	464
6	PS	"	Jul 8	189	181	79.79	458
8	PS	"	Jul 8	189	118	25.02	397
4	PS	"	Jul 9	190	131	34.16	484

Continued ...

Appendix Table 22. (Continued)

C12	PS	"	Jul 10	191	141	40.48	548
3	PS	"	Jul 21	202	141	39.78	620
3	PS	"	Jul 21	202	159	58.68	618
5	PS	"	Jul 21	202	183	74.00	596
5	PS	"	Jul 22	203	159	57.79	658
6	PS	"	Jul 22	203	160	60.40	663
4	PS	"	Jul 22	203	148	59.15	638
B26	PS	"	Jul 22	203	165	58.08	674
5	PS	"	Jul 22	203	155	57.76	659
2	PS	"	Jul 22	203	158	56.97	704
B15	PS	"	Jul 23	204	202	114.63	748
2*	bs	10/2/5	May 16	136	102	13.12	13
6	PS	"	May 27	147	100	11.46	29
6	PS	"	May 27	147	104	12.49	30
6	PS	"	Jun 9	160	110	14.50	54
8	PS	"	Jun 10	161	116	22.38	79
B17	PS	"	Jun 12	163	100	12.88	106
5	PS	"	Jun 24	175	125	23.95	221
2	PS	"	Jun 25	176	132	27.10	239
C12	PS	"	Jun 26	177	131	29.01	298
B10	PS	"	Jun 26	177	164	66.77	290
2	PS	"	Jul 7	188	179	79.33	374
B23	PS	"	Jul 8	189	151	59.46	432
5	PS	"	Jul 8	189	189	92.60	447
6	PS	"	Jul 8	189	170	71.20	456
5	PS	"	Jul 8	189	176	70.65	450
2	PS	"	Jul 8	189	157	45.99	386
5	PS	"	Jul 8	189	189	80.33	449
8	PS	"	Jul 8	189	170	75.60	398
B23	PS	"	Jul 8	189	165	72.71	433
4	PS	"	Jul 9	190	164	59.24	485
B5	PS	"	Jul 9	190	190	95.42	510
B6	PS	"	Jul 9	190	162	64.02	526
5	PS	"	Jul 21	202	217	141.66	593
4	PS	"	Jul 22	203	198	104.98	637
4	PS	"	Jul 22	203	148	44.66	639
8	PS	"	Jul 22	203	183	87.41	685
13*	bs	14/2/5	Jun 5	156	87	6.34	NA
6	PS	"	Jun 9	160	108	17.44	53
C5	PS	"	Jun 23	174	151	44.09	116
6	PS	"	Jun 24	175	110	16.46	170
B15	PS	"	Jun 26	177	119	24.18	311
4	PS	"	Jul 22	203	150	51.99	640
6	PS	"	Jul 22	203	150	45.56	664
7*	PS	Skykomish WA	Jul 8	189	163	60.75	421
B10*	PS	Capilano Hatch	Jul 23	204	208	115.16	740
5*	PS	Skagit WA	Jul 21	202	205	108.17	595

Total CWT's: 83 Total No Pins: 17 Total Pin Lost: 0 Grand Total: 100

+ It is assumed that these fish were coho smolts tagged in the estuary with chinook tag codes.
* These 9 fish were excluded from the CWT relative abundance analyses.

Appendix Table 23. Coho mark recoveries by purse seine in 1976. Recoveries sorted by CWT code and then by date of recovery.

Recapture Station	CWT Code	Recapture Date		Fork Length (mm)	Wet Weight (g)	Stomach Weight (g)
		Calendar	Julian			
C6	No Pin	Jul 6	188	159	51.85	2.03
6.5	"	Jul 7	189	135	33.88	3.68
2	"	Jul 20	202	183	82.40	3.56
6	"	Jul 20	202	129	26.86	0.80
6	"	Jul 20	202	153	45.62	4.24
6	"	Jul 21	203	176	74.77	3.24
C23	"	Jul 22	204	159	57.96	3.30
B29	"	Jul 22	204	138	31.93	2.28
3	"	Jul 23	205	144	34.41	0.74
3	"	Jul 23	205	149	43.94	1.08
B10	"	Aug 17	230	209	120.93	3.87
6	"	Aug 20	233	186	109.86	5.10
6	"	Aug 31	244	221	130.89	7.90
6	"	Aug 31	244	211	106.62	3.67
2	"	Aug 31	244	169	16.92	2.26
5	"	Sep 1	245	208	110.63	2.62
3	"	Sep 2	246	225	128.49	3.10
3	"	Sep 2	246	209	125.91	5.45
7	"	Sep 14	258	221	141.73	7.59
6	"	Sep 17	261	205	110.57	2.46
6	"	Sep 17	261	194	101.57	5.00
3	"	Sep 27	271	200	104.60	2.43
3	"	Sep 27	271	229	171.44	3.67
B23	"	Sep 29	273	221	157.47	11.09
6.5	"	Sep 29	273	234	162.70	5.78
3	"	Oct 1	275	215	120.53	2.60
3	"	Oct 12	286	245	201.76	3.36
6.5	Pin Lost	Jul 7	189	122	19.43	0.92
3	"	Jul 7	189	210	105.69	2.92
6	"	Jul 20	202	155	48.17	1.80
B10	"	Aug 17	230	204	104.87	5.97
2	"	Aug 18	231	218	117.11	4.33
3	"	Sep 27	271	202	116.40	5.82
3	"	Sep 29	273	267	189.37	7.03
3	"	Oct 15	289	248	168.46	4.34
3	"	Oct 15	289	223	160.86	3.19
3	3/2/7	Jun 21	173	110	19.66	0.33
6	"	Jun 22	174	75	4.22	0.17
6.5	"	Jul 7	189	135	26.28	1.40
6	"	Jul 20	202	135	30.52	0.69
B10	"	Jul 21	203	193	96.54	4.49
2	"	Jul 21	203	175	66.93	2.73
3	"	Jul 23	205	163	55.79	1.60
4*+	"	Aug 5	218	189	91.62	1.88
6.5*+	"	Aug 5	218	137	29.30	1.74
B10	"	Aug 17	230	206	135.38	9.55
B21	"	Aug 19	232	208	112.42	5.09
B10	"	Aug 30	243	217	135.46	3.79
3	"	Aug 31	244	183	67.02	3.27
A1	"	Sep 1	245	221	149.27	3.68
3.5	"	Sep 15	259	220	166.34	1.07
B13	"	Sep 30	274	260	208.35	5.15
3	"	Oct 12	286	239	158.82	3.38
3	"	Oct 13	287	194	87.04	3.13
5	4/2/7	Jul 7	189	114	16.39	0.69

Continued ...

Appendix Table 23. (Continued).

6.5	"	Jul 7	189	151	41.40	2.09
4	"	Jul 8	190	120	19.13	1.20
6.5	"	Jul 8	190	118	16.69	0.61
6.5	"	Jul 8	190	148	30.58	0.99
6	"	Jul 20	202	150	46.43	3.62
6.5	"	Jul 20	202	133	35.01	2.01
6	"	Jul 20	202	133	28.78	1.07
6	"	Jul 20	202	170	63.16	0.32
6	"	Jul 20	202	174	73.36	2.46
B10	"	Aug 4	217	199	95.13	3.50
2*+	"	Aug 5	218	189	74.30	2.97
6.5	"	Aug 5	218	173	63.36	3.63
6.5	"	Aug 5	218	200	104.91	1.11
6*+	"	Aug 5	218	171	61.97	2.87
2*+	"	Aug 5	218	179	66.24	3.48
B10	"	Aug 17	230	172	69.69	4.14
B10	"	Aug 17	230	195	107.89	8.12
B10	"	Aug 17	230	182	77.65	3.92
B10	"	Aug 17	230	224	136.67	9.23
B10	"	Aug 17	230	199	93.48	6.54
B10	"	Aug 17	230	167	57.90	2.12
B22*+	"	Aug 19	232	203	104.36	2.86
B22*+	"	Aug 19	232	177	79.08	5.50
2	"	Aug 20	233	149	40.52	0.79
2	"	Aug 20	233	178	67.90	2.28
2.5	"	Aug 20	233	176	75.72	3.96
6	"	Aug 20	233	200	109.27	2.92
6	"	Aug 20	233	194	98.78	4.78
6	"	Aug 20	233	173	61.11	1.66
5	"	Aug 31	244	198	95.83	2.25
5	"	Sep 1	245	190	85.68	2.73
5	"	Sep 1	245	165	51.08	3.79
6	"	Sep 1	245	202	105.66	7.38
6	"	Sep 1	245	218	142.80	9.85
5	"	Sep 1	245	227	124.38	2.71
4	"	Sep 2	246	222	132.90	3.01
3	"	Sep 2	246	206	126.07	4.29
2	"	Sep 2	246	194	96.70	2.62
1	"	Sep 14	258	222	173.21	5.19
6.5	"	Sep 14	258	205	124.09	4.49
5	"	Sep 14	258	218	145.23	10.22
6.5	"	Sep 14	258	181	82.11	5.77
6.5	"	Sep 14	258	214	132.34	5.60
3.5	"	Sep 15	259	228	173.53	9.11
B10	"	Sep 15	259	221	164.58	8.48
B10	"	Sep 15	259	230	178.11	4.02
C15	"	Sep 16	260	234	177.02	13.62
3	"	Sep 17	261	182	94.89	4.92
6	"	Sep 17	261	206	121.46	4.12
B23	"	Sep 29	273	236	167.96	4.00
B21	"	Sep 29	273	241	221.55	25.14
B10	"	Sep 29	273	264	187.65	8.62
3	"	Oct 1	275	230	260.47	9.27
3	"	Oct 12	286	225	140.32	2.49
3	"	Oct 13	287	238	161.10	3.84
4	"	Oct 13	287	271	237.34	4.89
3	"	Oct 15	289	221	132.62	4.49
B10	"	Oct 15	289	240	183.13	6.59
3	5/2/7	Jul 5	187	170	52.13	2.41
6.5	"	Jul 7	189	115	17.13	0.53
6	"	Jul 20	202	173	82.89	2.91

Continued ...

Appendix Table 23. (Continued).

B10	"	Jul 21	203	184	86.67	5.83
6.5	"	Aug 5	218	232	171.29	3.63
4*+	"	Aug 5	218	146	37.94	0.73
3*+	"	Aug 5	218	177	75.25	1.60
B22*+	"	Aug 19	232	216	133.58	3.79
2.5	"	Aug 20	233	212	114.26	4.13
5	"	Aug 31	244	205	101.93	3.15
4	"	Sep 1	245	207	121.18	6.62
B10	"	Sep 15	259	213	122.74	8.18
C5	"	Sep 16	260	279	299.39	16.91
3	"	Oct 13	287	250	157.59	3.63
S1	"	Oct 14	288	290	340.50	21.81
C6	6/2/7	Jul 6	188	140	32.96	1.57
3	"	Jul 7	189	127	24.14	0.50
6.5	"	Jul 9	191	144	36.75	2.29
2	"	Jul 20	202	160	55.35	1.23
3	"	Jul 20	202	147	39.09	1.45
6.5	"	Jul 20	202	159	56.14	3.68
8	"	Jul 21	203	141	35.34	1.45
4	"	Jul 21	203	164	53.81	2.90
6	"	Jul 21	203	165	62.90	3.46
B10	"	Jul 21	203	158	60.77	3.08
3	"	Jul 23	205	144	42.63	0.93
B10	"	Aug 4	217	189	93.86	7.03
B10	"	Aug 17	230	182	77.52	5.34
B10	"	Aug 17	230	221	134.04	11.46
6	"	Aug 18	231	208	130.79	8.11
2	"	Aug 18	231	194	98.13	6.25
3	"	Aug 18	231	201	122.24	6.87
2.5	"	Aug 20	233	208	116.80	7.26
B10	"	Aug 30	243	220	134.29	3.43
6	"	Aug 31	244	175	59.34	1.53
2	"	Aug 31	244	214	131.59	3.71
2	"	Aug 31	244	209	115.48	6.31
5	"	Aug 31	244	225	113.81	8.49
3	"	Aug 31	244	226	148.65	4.40
5	"	Sep 1	245	213	127.93	5.54
A1	"	Sep 1	245	229	151.00	6.92
4	"	Sep 2	246	195	86.59	4.12
6	"	Sep 14	258	222	169.56	4.40
C15	"	Sep 16	260	236	164.22	4.06
6	"	Sep 17	261	233	159.90	5.61
3	"	Sep 17	261	218	149.63	3.64
3	"	Sep 27	271	214	141.89	5.36
3	"	Oct 1	275	233	156.62	3.52
6	"	Oct 1	275	251	169.67	10.24
3	"	Oct 1	275	217	155.53	3.22
8	"	Oct 13	287	229	142.82	4.49
B10	"	Oct 15	289	282	263.49	4.27
3	"	Oct 27	301	227	131.51	3.54
6.5	7/2/7	Jul 7	189	130	24.20	1.27
3	"	Jul 8	190	148	37.67	1.24
3	"	Jul 8	190	120	21.38	1.02
6	"	Jul 20	202	150	40.82	1.92
6*+	"	Aug 5	218	182	84.31	3.00
6.5	"	Aug 5	218	187	89.24	4.36
B29	"	Aug 6	219	190	90.93	5.24
8	"	Aug 6	219	172	70.76	2.62
B10	"	Aug 19	232	219	133.05	4.86
2.5	"	Aug 20	233	202	112.15	8.55
2	"	Aug 20	233	197	99.01	5.81

Continued ...

Appendix Table 23. (Continued).

2	"	Aug 31	244	238	146.89	3.80
6	"	Sep 1	245	206	130.84	9.07
6	"	Sep 1	245	196	93.96	6.88
5*+	"	Sep 15	259	240	149.05	3.71
C15	"	Sep 16	260	226	153.24	5.98
B10	"	Oct 15	289	268	260.82	5.33
C22	8/2/7	Jul 6	188	186	75.97	4.58
6	"	Jul 8	190	168	51.34	1.75
6.5	"	Jul 9	191	158	42.68	1.86
2	"	Jul 20	202	172	65.55	2.32
6	"	Jul 21	203	166	60.81	1.65
B29	"	Jul 22	204	197	91.30	4.88
B10	"	Aug 19	232	246	180.61	5.23
6	"	Aug 20	233	144	34.94	0.71
2.5	"	Aug 20	233	206	132.66	4.47
2.5	"	Aug 20	233	174	69.23	3.54
5	"	Sep 1	245	249	208.37	7.33
2	"	Sep 2	246	217	152.59	3.31
2	"	Sep 2	246	224	156.81	4.48
B10	"	Sep 15	259	275	263.25	13.33
3.5	"	Sep 15	259	243	204.83	20.64
B10	"	Oct 15	289	258	226.00	6.60
3	"	Oct 15	289	277	286.35	8.28
3	9/2/7	Jul 5	187	106	13.41	0.86
6.5	"	Jul 8	190	144	36.71	4.57
6	"	Jul 20	202	151	43.19	1.55
6	"	Jul 20	202	145	41.09	1.62
8*+	"	Aug 5	218	181	79.36	2.73
6	"	Aug 6	219	148	45.15	1.46
5	"	Aug 6	219	134	33.11	2.04
B10	"	Aug 17	230	201	109.94	8.03
B10	"	Aug 17	230	206	116.58	7.41
8	"	Aug 31	244	206	115.20	3.92
2	"	Aug 31	244	198	99.45	2.40
5	"	Aug 31	244	199	93.51	2.28
A1	"	Sep 1	245	239	159.39	5.12
6	"	Sep 14	258	208	132.12	4.55
C5	"	Sep 16	260	262	239.01	4.88
8	"	Sep 28	272	215	126.96	6.12
B5	"	Sep 29	273	235	164.57	4.08
C5	"	Sep 30	274	252	195.10	14.58
3	"	Oct 1	275	251	111.77	6.04
B10	"	Oct 15	289	268	247.67	4.53
3	"	Oct 15	289	245	207.53	11.76
B6	"	Oct 27	301	250	179.91	4.51
6.5	10/2/7	Jul 7	189	150	43.40	2.51
6	"	Jul 20	202	124	21.14	1.33
B10	"	Jul 21	203	165	67.94	3.28
B10	"	Jul 21	203	169	62.93	1.67
B10	"	Aug 17	230	169	69.51	6.20
B10	"	Aug 17	230	215	145.51	5.71
B10	"	Aug 17	230	216	137.79	5.75
2	"	Aug 20	233	200	127.96	6.45
4	"	Sep 2	246	233	158.49	2.96
2	"	Sep 2	246	204	119.43	7.36
B13	"	Sep 30	274	238	185.20	8.04
3	"	Oct 25	299	195	108.44	8.13
5	11/2/5	Jul 7	189	118	16.97	0.83
3	"	Jul 8	190	128	25.52	1.44
6.5	"	Jul 8	190	135	26.48	1.75

Continued ...

Appendix Table 23. (Continued).

6	"	Jul 20	202	154	47.58	1.38
6	"	Jul 20	202	154	54.85	3.43
B15	"	Jul 21	203	163	31.79	1.53
B10	"	Jul 21	203	172	65.18	2.15
B29	"	Jul 22	204	180	79.27	4.90
C23	"	Jul 22	204	157	50.18	3.42
C23	"	Jul 22	204	162	54.77	4.02
C23	"	Jul 22	204	160	54.52	3.86
3	"	Jul 23	205	137	35.09	1.13
B10	"	Aug 4	217	199	116.78	8.41
6*+	"	Aug 5	218	190	79.25	1.65
2*+	"	Aug 5	218	189	83.99	4.86
8*+	"	Aug 5	218	163	65.65	4.41
B10	"	Aug 17	230	196	101.49	5.78
B10	"	Aug 17	230	200	107.17	5.68
B10	"	Aug 17	230	219	147.57	7.81
B10	"	Aug 17	230	209	125.74	7.94
B10	"	Aug 19	232	224	140.20	5.00
1	"	Aug 20	233	224	159.65	5.56
2.5	"	Aug 20	233	222	143.73	9.63
2	"	Aug 20	233	119	100.20	9.65
3	"	Aug 31	244	209	118.16	4.07
2	"	Aug 31	244	149	28.00	1.13
5	"	Sep 1	245	240	185.36	6.12
5	"	Sep 1	245	177	65.10	1.69
4	"	Sep 2	246	231	168.95	9.54
2	"	Sep 2	246	247	196.55	6.12
5	"	Sep 14	258	214	145.89	3.93
3.5	"	Sep 15	259	210	135.38	6.92
3.5	"	Sep 15	259	225	169.03	8.39
3.5	"	Sep 15	259	226	138.52	2.45
C15	"	Sep 16	260	248	202.29	10.58
B23	"	Sep 29	273	265	218.57	4.58
3	"	Oct 15	289	247	187.65	9.57
5	13/2/7	Jul 5	187	139	29.80	1.54
C23	"	Jul 22	204	171	64.16	5.00
B10	"	Aug 4	217	213	150.98	17.30
4*+	"	Aug 5	218	192	91.74	2.49
B10	"	Aug 17	230	222	151.82	7.14
2	"	Aug 31	244	241	153.87	3.21
S1	"	Oct 14	288	320	454.00	10.00
C5*	13/10/5	Sep 30	274	279	250.18	5.65
B22*	Samish WA	Jul 21	203	232	170.55	6.01
4*	Skagit WA	Sep 2	246	215	130.96	3.09
B10*	Skagit WA	Aug 17	230	197	99.78	5.29
6*	Skagit WA	Sep 1	245	233	167.42	5.81

Total CWT's: 247 Total No Pins: 27 Total Pin Lost: 9 Grand Total: 283

* These 22 tagged fish were excluded from the relative abundance analyses.
\+ These 17 tagged fish were not recorded on available field record sheets.

Appendix Table 24. Total purse seine catch of coded wire tagged chinook, 1975 and 1976.

Date	1975 (CWT Code 7/2/5) Head	Edge	Outside	Total	Sets	1976 (CWT Code 1/2/7) Head*	Edge*	Outside	Total*	Sets
Apr 16-30	-	-	-	-	16					
May 1-15	-	-	-	-	16					
May 16-31	-	-	-	-	16	-	-	-	-	8
Jun 1-15	-	-	-	-	21	-	-	-	-	16
Jun 16-31	-	-	-	-	28	-	-	-	-	13
Jul 1-15	2	-	-	2	31	39(4)	23(22)	-	62(26)	33
Jul 16-31	6	3	4	13	29	30	1(1)	-	31(1)	31
Aug 1-15						15	7(6)	-	22(6)	11
Aug 16-31						32	34(13)	2	68(13)	32
Sep 1-15						29(2)	7(1)	-	36(3)	26
Sep 16-30						17	2	2	21	40
Oct 1-15						18	3	1	22	33
Oct 16-31						14(2)	2	-	16(2)	30
Total	8	3	4	15	157	194(8)	79(43)	5	278(51)	273

* Catch of CWTs at stations 2.5, 3.5, 4.5, and 6.5 in brackets. Fish marked with "*" in Appendix Tables 20 and 21 are excluded from this table.

Appendix Table 25. Purse seine catch and CPUE of unmarked and CWT chinook for the same head and edge of Cowichan Bay stations, and for all outside Cowichan Bay stations, in July 1975 and in July 1976. CWT CPUE has been adjusted to a standard number of tag releases.*

Years	Grouped Stations			
	Head	Edge	Inside Total	Outside Total
		Unmarked Catch		
July 1975	864	256	1,120	658
July 1976	670	361	1,031	47
Total	1,534	617	2,151	705
		Catch per 100 sets		
July 1975	5,400	1,600	3,500	2,350
July 1976	2,393	3,610	2,713	313
Avg CPUE	3,896	2,605	3,107	1,332
		CWT Catch**		
July 1975	12	3	15	7
July 1976	64	1	65	-
Total	76	4	80	7
		CWT Catch per 100 sets		
July 1975	113	28	71	38
July 1976	357	16	267	0
Avg CPUE	235	22	169	19

* Source: Unmarked catch and set data from Appendix Tables 5, 7, 18 and 19; CWT catch from Appendix Table 24. Catch at stations 2.5, 3.5, 4.5 and 6.5 excluded.

** The 1975 CWT catch has been increased to account for marks that were not returned from the field (4 marks added for head stations and 3 marks added for outside stations).

Appendix Table 26. Purse seine catch and CPUE of unmarked and CWT chinook in 1976 for all head, edge and outside Cowichan Bay stations. CWT CPUE has been adjusted to a standard number of tag releases.*

Months	Grouped Stations			
	Head	Edge	Inside Total	Outside Total
		Unmarked Catch		
Jul-Aug	1,052	1,211	2,263	238
Sep-Oct	1,186	220	1,406	113
Total	2,238	1,431	3,669	351
		Catch per 100 Sets		
Jul-Aug	2,505	3,187	2,829	881
Sep-Oct	1,853	1,100	1,674	251
Avg CPUE	2,179	2,143	2,251	566
		CWT Catch		
Jul-Aug	116	65	181	2
Sep-Oct	78	14	92	3
Total	194	79	273	5
		CWT Catch per 100 Sets		
Jul-Aug	431	267	353	12
Sep-Oct	190	109	171	10
Avg CPUE	311	188	262	11

* Source: Unmarked catch from Appendix Tables 7 and 19; CWT catch from Appendix Table 24.

Appendix Table 27. Total purse seine catch of coded-wire tagged coho, 1975.*

	Tagging Location						
	Rotary Park Pools			Pastuch Creek	Cowichan Side Channel		Number of
	8/2/5	10/2/5	9/2/5	6/2/5	14/2/5	Total	Sets
Apr 16-30							
Head of Bay	-	-	-	-	-	-	8
Edge of Bay	-	-	-	-	-	-	8
Outside Bay	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	16
MAY 1-15							
Head of Bay	-	-	-	-	-	-	8
Edge of Bay	-	-	-	-	-	-	8
Outside Bay	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	16
MAY 16-31							
Head of Bay	-	2	-	-	-	2	8
Edge of Bay	-	-	-	-	-	-	8
Outside Bay	-	-	-	-	-	-	-
Total	-	2	-	-	-	2	16
JUNE 1-15							
Head of Bay	-	1	1	-	1	3	8
Edge of Bay	-	1	2	-	-	3	8
Outside Bay	-	1	-	-	-	1	5
Total	-	3	3	-	1	7	21
JUNE 16-30							
Head of Bay	-	1	1	1	1	4	8
Edge of Bay	-	1	3	1	-	5	8
Outside Bay	-	2	4	2	2	10	12
Total	-	4	8	4	3	19	28
JULY 1-15							
Head of Bay	-	5	4	2	-	11	8
Edge of Bay	-	3	2	3	-	8	8
Outside Bay	-	4	3	2	-	9	15
Total	-	12	9	7	-	28	31
JULY 16-31							
Head of Bay	-	3	7	1	2	13	8
Edge of Bay	-	1	1	-	-	2	8
Outside Bay	-	-	2	1	-	3	13
Total	-	4	10	2	2	18	29
ALL MONTHS							
Head of Bay	-	12	13	4	4	33	56
Edge of Bay	-	6	8	4	-	18	56
Outside Bay	-	7	9	5	2	23	45
Total	-	25	30	13	6	74	157

* Fish marked with "*" in Appendix Table 22 excluded from this table.

Appendix Table 28. Total purse seine catch of coded-wire tagged coho, 1976.*

	Tagging Location											
	Pastuch Creek	Mesachie Creek				Side Channel	Rotary Park Pools		Kelvin Creek		Total	Number of Sets
	9/2/7	7/2/7	8/2/7	13/2/7	11/2/5	10/2/7	5/2/7	6/2/7	3/2/7	4/2/7		
MAY 16-31												
Head of Bay	-	-	-	-	-	-	-	-	-	-	-	4
Edge of Bay	-	-	-	-	-	-	-	-	-	-	-	4
Outside Bay	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-	-	8
JUNE 1-15												
Head of Bay	-	-	-	-	-	-	-	-	-	-	-	6
Edge of Bay	-	-	-	-	-	-	-	-	-	-	-	4
Outside Bay	-	-	-	-	-	-	-	-	-	-	-	6
Total	-	-	-	-	-	-	-	-	-	-	-	16
JUNE 16-31												
Head of Bay	-	-	-	-	-	-	-	-	2	-	2	9
Edge of Bay	-	-	-	-	-	-	-	-	-	-	-	4
Outside Bay	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	2	-	2	13
JULY 1-15												
Head of Bay	1	2	1	1	2	-	1	1	-	2	11	18
Edge of Bay	1	1	1	-	1	1	1	1	1	3	11(11)	11
Outside Bay	-	-	1	-	-	-	-	1	-	-	2	4
Total	2	3	3	1	3	1	2	3	1	5	24	33
JULY 16-31												
Head of Bay	2	1	1	-	3	1	1	4	2	4	19	11
Edge of Bay	-	-	1	-	-	-	-	3	1	1	6(2)	9
Outside Bay	-	-	1	1	6	2	1	1	1	-	13	11
Total	2	1	3	1	9	3	2	8	4	5	38	31
AUGUST 1-15												
Head of Bay	2	-	-	-	-	-	-	-	-	-	2	4
Edge of Bay	-	2	-	-	-	-	1	-	-	2	5(5)	5
Outside Bay	-	1	-	1	1	-	-	1	-	1	5	2
Total	2	3	-	1	1	-	1	1	-	3	12	11
AUGUST 16-31												
Head of Bay	1	-	1	-	1	-	1	5	1	4	14	9
Edge of Bay	2	3	2	1	4	1	1	4	-	3	21(7)	13
Outside Bay	2	1	1	1	5	3	-	3	3	6	25	10
Total	5	4	4	2	10	4	2	12	4	13	60	32
SEPTEMBER 1-15												
Head of Bay	1	2	2	-	7	1	1	3	1	9	27(6)	14
Edge of Bay	-	-	2	-	1	1	-	-	-	5	9(3)	6
Outside Bay	1	-	1	-	-	-	1	1	1	2	7	6
Total	2	2	5	-	8	2	2	4	2	16	43	26
SEPTEMBER 16-30												
Head of Bay	-	-	-	-	-	-	-	3	-	2	5	16
Edge of Bay	1	-	-	-	-	-	-	-	-	-	1	5
Outside Bay	3	1	-	-	2	1	1	1	1	4	14	19
Total	4	1	-	-	2	1	1	4	1	6	20	40
OCTOBER 1-15												
Head of Bay	2	-	1	-	1	-	1	3	2	5	15	15
Edge of Bay	-	-	-	-	-	-	-	1	-	-	1	4
Outside Bay	1	1	1	1	-	-	1	1	-	1	7	14
Total	3	1	2	-	1	-	2	5	2	6	22	33
OCTOBER 16-31												
Head of Bay	-	-	-	-	-	1	-	1	-	-	2	19
Edge of Bay	-	-	-	-	-	-	-	-	-	-	-	5
Outside Bay	1	-	-	-	-	-	-	-	-	-	1	6
Total	1	-	-	-	-	1	-	1	-	-	3	30
ALL MONTHS												
Head of Bay	9	5	6	1	14	3	5	20	8	26	97(6)	125
Edge of Bay	4	6	6	1	6	3	3	9	2	14	54(28)	70
Outside Bay	8	4	5	4	14	6	4	9	6	14	74	78
Total	21	15	17	6	34	12	12	38	16	54	225(34)	273

* Catch of CWT tagged fish at stations 2.5, 3.5, 4.5, and 6.5 in brackets. Fish marked with "*" in Appendix Table 23 excluded from this table.

Appendix Table 29. Purse seine catch and CPUE of CWT coho from early and late releases of lower river coho smolts, for the same head and edge of Cowichan Bay stations, and for all outside Cowichan Bay stations, July 1975 and July 1976. CWT CPUE has been adjusted to a standard number of tag releases.*

Time of CWT Release	Time of CWT Recovery	Grouped Stations			
		Head	Edge	Inside Total	Outside Total
		Early Release CWT Catch			
1975 **	July	11	4	15	4
1976	July	4	1	5	2
	Total	15	5	20	6
		Late Release CWT Catch			
1975 **	July	15	3	18	5
1976	July	11	2	13	2
	Total	26	5	31	7
		Catch of Early Release CWTs per 100 Sets			
1975	July	175	64	119	36
1976	July	34	24	31	32
Avg CPUE	Total	104	44	75	34
		Catch of Late Release CWTs per 100 Sets			
1975	July	353	71	212	67
1976	July	86	44	75	29
	Average CPUE	220	57	143	48
		Average CPUE			
1975	July	264	67	166	52
1976	July	60	34	53	30
	Average CPUE	162	50	109	41

* Source: CWT catch data from Appendix Tables 27 and 28. Catch at stations 2.5, 3.5, 4.5 and 6.5 excluded.

** The CWT catch in 1975 has been increased to account for marks that were not returned from the field (3 marks added for early release head stations, and 4 marks added for late release head stations).

Appendix Table 30. Purse seine recoveries of CWT coho from lower/upper river, early/late releases, 1976. Recoveries are presented for all head, edge and outside Cowichan Bay stations. CWT CPUE has been adjusted to a standard number of tag releases.*

Time of CWT Release	Time of CWT Recovery	Lower River				Upper River				Total			
		Head	Edge	Inside Total	Outside Total	Head	Edge	Inside Total	Outside Total	Head	Edge	Inside Total	Outside Total
						CWT Catch							
Early	Jul-Aug	6	5	11	5	7	11	18	8	13	16	29	13
	Sep-Oct	5	-	5	5	5	2	7	5	10	2	12	10
	Total	11	5	16	10	12	13	25	13	23	18	41	23
Late	Jul-Aug	20	17	37	13	6	5	11	12	26	22	48	25
	Sep-Oct	26	6	32	10	8	1	9	2	34	7	41	12
	Total	46	23	69	23	14	6	20	14	60	29	89	37
Total	Jul-Aug	26	22	48	18	13	16	29	20	39	38	77	38
	Sep-Oct	31	6	37	15	13	3	16	7	44	9	53	22
	Total	57	28	85	33	26	19	45	27	83	47	130	60
						Catch of CWTs per 100 Sets				Average CPUE			
Early	Jul-Aug	34	31	33	44	15	26	21	27	25	29	27	35
	Sep-Oct	18	0	14	26	7	9	8	10	13	5	11	18
	Avg CPUE	26	16	23	35	11	18	14	19	19	17	19	27
Late	Jul-Aug	104	98	101	105	31	29	30	97	68	63	66	101
	Sep-Oct	89	66	83	49	27	11	23	10	58	38	53	29
	Avg CPUE	97	82	92	77	29	20	27	53	63	51	59	65
Average CPUE	Jul-Aug	69	65	67	75	23	28	25	62	46	46	46	68
	Sep-Oct	54	33	49	37	17	10	15	10	35	21	32	24
	Average	61	49	58	56	20	19	20	36	41	34	39	46

* Source: CWT catch from Appendix Table 28.

Appendix Table 31. Purse seine catch and CPUE of unmarked coho and of CWT coho from early and late releases of lower river coho smolts, for the same head and edge of Cowichan Bay stations, and for all outside Cowichan Bay stations, July 1975 and July 1976. CWT CPUE has been adjusted to a standard number of tag releases and has been averaged over early and late releases.*

Years	Grouped Stations			
	Head	Edge	Inside Total	Outside Total
		Unmarked Catch		
July 1975	950	283	1,233	321
July 1976	368	58	426	283
Total	1,318	341	1,659	604
		Catch per 100 sets		
July 1975	5,938	1,769	3,853	1,146
July 1976	1,314	580	1,121	1,887
Avg CPUE	3,626	1,174	2,487	1,517
		Catch of Lower River CWTs**		
July 1975	26	7	33	9
July 1976	15	3	18	4
Total	41	10	51	13
		Average CWT Catch per 100 Sets (Lower River)		
July 1975	264	67	166	52
July 1976	60	34	53	30
Avg CPUE	162	50	109	41

* Source: Unmarked catch data from Appendix Tables 14, 16, 18 and 19; CWT catch and average CPUE from Appendix Table 29. Catch at stations 2.5, 3.5, 4.5 and 6.5 excluded.

** The CWT catch in 1975 has been increased to account for marks that were not returned from the field (3 marks added for early release head stations, and 4 marks added for late release head stations).

Appendix Table 32. Purse seine catch and CPUE in 1976 of unmarked coho and selected groups of CWT coho for all head, edge and outside Cowichan Bay stations. CWT CPUE has been adjusted to a standard number of tag releases and has been averaged over upper and lower river, and over early and late releases.*

Months	Grouped Stations			
	Head	Edge	Inside Total	Outside Total
		Unmarked Catch		
Jul-Aug	508	522	1,030	517
Sep-Oct	635	122	757	377
Total	1,143	644	1,787	894
		Catch per 100 Sets		
Jul-Aug	1,210	1,374	1,288	1,915
Sep-Oct	992	610	901	838
Total	1,078	1,110	1,090	1,242
		Total CWT Catch		
Jul-Aug	39	38	77	38
Sep-Oct	44	9	53	22
Total	83	47	130	60
		Average CWT Catch per 100 Sets		
Jul-Aug	46	46	46	68
Sep-Oct	35	21	32	24
Total	41	34	39	46

* Source: Unmarked catch from Appendix Tables 16 and 19; CWT catch and average CPUE from Appendix Table 30.

Appendix Table 33. Average fork length at recapture of marked chinook recovered by purse seine at sampling stations inside Cowichan Bay, 1976.

	Inside Cowichan Bay		
	All Stations	Head of Bay	Edge of Bay
JULY 1-15			
Sample Size	65	42	23
Avg. Length (cm)	88.2	84.6	94.7
Standard Error	1.65	1.69	3.11
JULY 16-31			
Sample Size	33	32	1
Avg. Length (cm)	110.9	111.4	94
Standard Error	2.77	2.8	
AUGUST 1-15			
Sample Size	32	21	11
Avg. Length (cm)	123.2	119.8	129.9
Standard Error	4	5.02	6.4
AUGUST 16-31			
Sample Size	71	34	37
Avg. Length (cm)	143.1	137.4	148.2
Standard Error	2.58	3.74	3.39
SEPTEMBER 1-15			
Sample Size	39	31	8
Avg. Length (cm)	147.4	146.4	151.2
Standard Error	3.72	4.24	8.03
SEPTEMBER 16-30			
Sample Size	21	18	3
Avg. Length (cm)	168.6	165.7	185.7
Standard Error	6.15	6.91	6.49
OCTOBER 1-15			
Sample Size	24	21	3
Avg. Length (cm)	159.9	157	180.7
Standard Error	4.19	3.97	16.27
OCTOBER 16-31			
Sample Size	17	15	2
Avg. Length (cm)	175.1	177.7	156
Standard Error	3.43	3.16	12

Appendix Table 34. Average fork length at recapture of marked coho recovered by purse seine at sampling stations inside and outside Cowichan Bay, 1975.

	Inside Cowichan Bay	Outside Cowichan Bay
MAY 16-31		
Sample Size	2	
Avg. Length (mm)	102.0	
Standard Error	2.00	
JUNE 1-15		
Sample Size	8	2
Avg. Length (mm)	106.1	106.5
Standard Error	3.04	6.50
JUNE 16-30		
Sample Size	14	11
Avg. Length (mm)	118.5	128.4
Standard Error	2.78	6.67
JULY 1-16		
Sample Size	23	10
Avg. Length (mm)	162.3	148.4
Standard Error	4.81	7.26
JULY 16-31		
Sample Size	17	6
Avg. Length (mm)	169.5	176
Standard Error	6.32	11.52

Appendix Table 35. Average fork length at recapture of marked coho recovered by purse seine at sampling stations inside and outside Cowichan Bay, 1976.

	Inside Cowichan Bay	Outside Cowichan Bay
JULY 1-15		
Sample Size	25	3
Avg.Length (mm)	138.1	161.7
Standard Error	4.52	13.35
JULY 16-31		
Sample Size	32	16
Avg.Length (mm)	154.0	172.5
Standard Error	2.70	5.40
AUGUST 1-15		
Sample Size	20	5
Avg.Length (mm)	176.6	198.0
Standard Error	5.14	4.31
AUGUST 16-31		
Sample Size	40	31
Avg.Length (mm)	196.5	204.5
Standard Error	4.09	3.29
SEPTEMBER 1-15		
Sample Size	43	7
Avg.Length (mm)	215.1	232.6
Standard Error	2.76	7.73
SEPTEMBER 16-30		
Sample Size	13	16
Avg.Length (mm)	215.3	248.5
Standard Error	6.04	4.49
OCTOBER 1-15		
Sample Size	20	7
Avg.Length (mm)	237.4	275.1
Standard Error	4.33	9.65
OCTOBER 16-31		
Sample Size	2	1
Avg.Length (mm)	211	250
Standard Error	16.00	-

Appendix Table 36. CWT coho fork lengths, chosen at random from recoveries at inside Cowichan Bay stations, that were used in analyses of variance.*

Recovery Time Period/ Location	Year	Length (mm)	Avg.
July 1-15 early Rotary	1975	189	
	1975	157	
	1975	189	
	1975	170	
	1976	170	175.0
July 1-15 late Rotary	1975	131	
	1975	163	
	1975	181	
	1975	172	
	1976	144	158.2
July 16-31 early Rotary	1975	217	
	1975	198	
	1975	148	
	1975	183	
	1976	173	183.8
July 16-31 late Rotary	1975	155	
	1975	160	
	1975	159	
	1975	148	
	1976	165	157.4
Jul 1-15 early Mesachie	1976	168	
	1976	158	
	1976	139	155.0
Jul 1-15 late Mesachie	1976	118	
	1976	128	
	1976	135	127.0
Jul 16-31 early Mesachie	1976	172	
	1976	166	
	1976	150	162.7
Jul 16-31 late Mesachie	1976	154	
	1976	154	
	1976	137	148.3
Aug 16-31 early Mesachie	1976	144	
	1976	206	
	1976	174	
	1976	241	191.3
Aug 16-31 late Mesachie	1976	222	
	1976	209	
	1976	224	
	1976	119	193.5
Sept 1-15 early Mesachie	1976	224	
	1976	249	
	1976	243	
	1976	217	233.3
Sept 1-15 late Mesachie	1976	177	
	1976	210	
	1976	226	
	1976	240	213.3

* Source: Appendix Table 22 and 23.

Appendix Table 37. Grouping of 1973 stomach content items. Groups are: 1, marine zooplankton; 2, larval and juvenile fishes 3, estuarine benthic organisms; 4, larvae of benthos; 5, various eggs; 6, insects; blank, not assigned.

Item Number	Item Group	Computer Code	Prey Item
1	1	1	Calanus glacialis (Copepoda)
2	1	2	Calanus plumchrus (Copepoda)
3	1	5	Metridia lucens (Coelenterata)
4	1	14	Epilabidocera sp. (Copepoda)
5	1	48	Parasitic copepod (Copepoda)
6	1	53	Parathemisto pacifica (Amphipoda)
7	1	54	Cyphocaris challengeri
8	1	75	Euphausia pacifica (Euphausiacea)
9	1	149	Tunicates (Tunicata)
10	2	111	Herring (Clupea harengus pallasi)
11	2	112	Salmon (Oncorhynchus sp.)
12	2	114	Eulachon (Thaleichthys pacificus)
13	2	120	Unidentified fish larvae
14	3	23	Harpacticoid copepod (Copepoda)
15	3	51	Anisogammarus sp. (Amphipoda)
16	3	52	Corophium sp. (Amphipoda)
17	3	70	Shrimp (Decapoda)
18	3	122	Mysids (Mysidae)
19	3	125	Unidentified polychaete (Polychaeta)
20	3	131	Pulmonata
21	4	69	Shrimp zoea and megalops (Decapoda)
22	4	71	Crab zoea (Decapoda)
23	4	72	Crab megalops (Decapoda)
24	5	142	Unidentified egg
25	6	90	Diptera (Insecta)
26	6	96	Chironomid larvae (Insecta)
27	6	97	Homoptera (Insecta)
28	6	101	Hymenoptera (Insecta)
29	6	109	Insect larvae (Insecta)

Appendix Table 38. Grouping of 1976 stomach content items. Groups are: 1, marine zooplankton; 2, larval and juvenile fishes; 3, estuarine benthic organisms; 4, larvae of benthos; 5, various eggs; 6, insects; blank, not assigned.

Item Number	Item Group	Computer Code	Prey Item
1	1	RK5	Parasitic Copepod
2	1	RM6	Calanus pacificus
3	1	RP0	Calanus marshallae (Copepoda)
4	1	UH0	Epilabidocera amphitrites (Copepoda)
5	1	WQ0	Isopods (Isopoda)
6	1	XE0	Hyperid Amphipod (Amphipoda)
7	1	XF4	Primno (Amphipoda)
8	1	XG5	Hyperoche (Amphipoda)
9	1	XG9	Parathemisto (Amphipoda)
10	1	XM0	Euphausiids (Euphausiacea)
11	1	XN0	Euphausia pacifica (Euphausiacea)
12	1	XN8	Thysanoessa raschii (Euphausiacea)
13	1	RPD	Calanus (Copepoda)
14	2	097	Herring larvae (Clupea harengus pallasi)
15	2	096	Herring (Clupea harengus pallasi)
16	2	455	Sablefish (Anoplopoma fimbria)
17	2	430	Rockfish (Sebastes)
18	3	PR0	Polychaetes (Polychaeta)
19	3	RG2	Philomedes (Ostracoda)
20	3	UY0	Harpacticoid copepods (Copepoda)
21	3	WA0	Mysid (Mysidae)
22	3	WW0	Anisogammarus (Amphipoda)
23	3	WW3	Anisogammarus confervicolus (Amphipoda)
24	3	WW6	Corophium (Amphipoda)
25	3	WW7	Corophium spinicorne (Amphipoda)
26	3	XJ5	Caprellid amphipod (Amphipoda)
27	3	YH0	Shrimp (Decapoda)
28	4	XS1	Brachyuran zoea (Decapoda)
29	4	XS2	Crab megalops (Decapoda)
30	4	YJ2	Porcellana zoea (Decapoda)
31	5	D64	Unidentified Egg
32	6	Y00	Isoptera (Insecta)
33	6	Y30	Coleoptera (Insecta)
34	6	Y50	Lepidoptera (Insecta)
35	6	Y55	Diptera (Insecta)
36	6	Y58	Diptera pupae (Insecta)
37	6	Y63	Chironomid larvae (Insecta)
38	6	Y70	Hymenoptera (Insecta)
39	6	Y80	Psocoptera (Insecta)
40	6	Y95	Thysanoptera (Insecta)
41	6	Z00	Homoptera (Insecta)
42	6	Z05	Hemiptera (Insecta)
43	6	Z40	Arachnids (Arachnida)
44	6	Z41	Pycnogonida (Arachnida)
45		700	?
46		999	?
47		P00	Nematodes (Nematoda)
48		RL0	Anthocyrtium (?)
49		RP7	Cenosphaera (?)
50		WT0	?
51		WW2	Ampipod (Amphipoda)
52		X31	?
53		XM6	?
54		Y57	?
55		YS5	?
56		YU0	?
57		YZ0	?
58		ZV5	?